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PB80-110190

Estech General Chemicals Corporation Duette Mine, Manatee County, Florida Resource Document: Biology and Ecology

Conservation Consultants, Inc, Palmetto, FL

Prepared for

Environmental Protection Agency, Atlanta, GA Region IV

Oct 79

PB80-110190

United States
Environmental Protection
Agency

Region 4
345 Courtland Street, NE
Atlanta, GA 30308

EPA 904/9-79-044M
October 1979

EPA

Environmental Impact Statement

DRAFT

Estech General Chemicals Corporation
Duette Mine
Manatee County, Florida

BIOLOGY AND ECOLOGY

RESOURCE DOCUMENT

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SPRINGFIELD, VA. 22161

BIBLIOGRAPHIC DATA SHEET

1. Report No. EPA 904/9-79-044M

2.

3. Recipient's Accession No. PB 80 110190

4. Title and Subtitle
Draft EIS Estech General Chemicals Corporation, Duette Mine, Manatee County, Florida, volume M

5. Report Date October 1979

6.

7. Author(s) EIS Branch, EIS Preparation Section

8. Performing Organization Rept. No.

9. Performing Organization Name and Address
Conservation Consultants, Inc.
P.O. Box 35
Palmetto, FL 33561

10. Project/Task/Work Unit No.

11. Contract/Grant No.

12. Sponsoring Organization Name and Address
EIS Branch, U.S. EPA
345 Courtland St.
Atlanta, GA 30308

13. Type of Report & Period Covered Draft EIS

14.

15. Supplementary Notes

16. Abstracts

The Draft Environmental Impact Statement for the Estech General Chemicals (formerly Swift Agricultural Chemical) Duette Mine is enclosed for your review and comment. The document has been prepared pursuant to Section 102(2)(c) of the National Environmental Policy Act (NEPA) (Public Law 91-190) and applicable EPA regulations at 40 CFR Part 6.9. Thirteen volumes of resource documents were also prepared. These resource documents comprise the detailed technical evaluations of the alternatives and the proposed action and contain supporting data related to the Draft EIS. While the Draft EIS is a complete document.

17. Key Words and Document Analysis. 17a. Descriptors

Volume M
Duette Mine
Manatee County
Biology and Ecology

17b. Identifiers/Open-Ended Terms

17c. COSATI Field Group

18. Availability Statement

19. Security Class (This Report) UNCLASSIFIED

20. Security Class (This Page) UNCLASSIFIED

21. No. of Pages 211

22. Price A10-A01

FORM NTIS-35 (REV. 10-73) ENDORSED BY ANSI AND UNESCO. THIS FORM MAY BE REPRODUCED USCOMM-DC 8265-P74

BIOLOGY AND ECOLOGY

RESOURCE DOCUMENT

Draft Environmental Impact Statement

Swift Agricultural Chemicals Corporation
Duette Mine Site
Manatee County, Florida

Prepared For: U. S. Environmental Protection Agency
Region IV
345 Courtland Street. N.E.
Atlanta, GA 30308

Prepared By: Conservation Consultants, Inc.
P. O. Box 35
Palmetto, FL 33561

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BIOLOGY AND ECOLOGY
RESOURCE DOCUMENT

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NOTE:

Effective August 1, 1979, Swift Agricultural Chemicals Corporation changed its name to Estech General Chemicals Corporation.

The preparation of the Draft Environmental Impact Statement was substantially completed at the time of the name change. Therefore, the name of Swift Agricultural Chemicals Corporation (Swift) is used throughout the Draft Environmental Impact Statement and all attendant Resource Documents.

PART I BIOLOGY AND ECOLOGY BASELINE

1. INTRODUCTION

The biological and ecological baseline characteristics of the Duette mine property are treated under three major headings:

- Land (Description of terrestrial plant and animal communities).
- Land-Water Interface (Description of plant and animal communities inhabiting swamps and marshes).
- Water (Description of aquatic plant and animal communities).

Initial field reconnaissance revealed four land communities and three land-water interface communities. In addition, aquatic vegetation occurred in the streams, and ruderal vegetation occupied those sites where the land communities had been disturbed by intensive land use.

Except for aquatic vegetation, these vegetation types were discernible from aerial photographs (black and white, 1" = 1,000'; infrared, 1" = 500'). A vegetation map (Figure 1-1) was prepared from these photographs and the acreage of each type determined. The natural communities and their acreages were:

Land	
Sand Pine Scrub	73
Longleaf Pine-Xeric Oak	35
Xeric Oak	518
Longleaf Pine Flatwoods	5,673
LAND-WATER INTERFACE	
Fresh Water Swamp	1,219
Fresh Water Marsh	600
Cypress Swamp	18
WATER	
Streams	

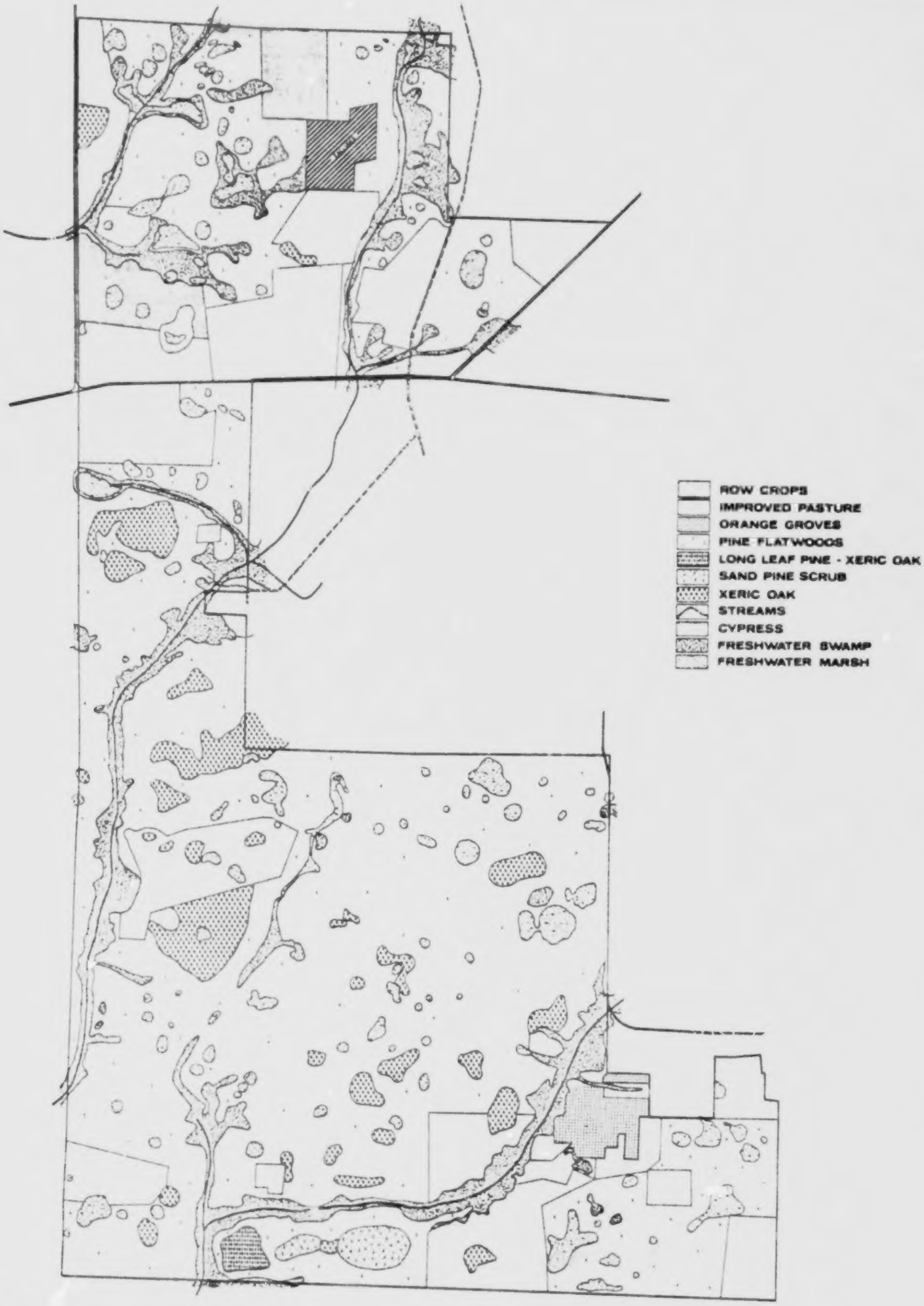
ROW CROPS
IMPROVED PASTURE
ORANGE GROVES
PINE FLATWOODS
LONG LEAF PINE - XERIC OAK
SAND PINE SCRUB
XERIC OAK
STREAMS
CYPRESS
FRESHWATER SWAMP
FRESHWATER MARSH

FIGURE 1-1

VEGETATION MAP

Source: Ardaman and Associates, Inc.

U.S. EPA-REGION IV
DRAFT ENVIRONMENTAL
IMPACT STATEMENT FOR
SWIFT AGRICULTURAL CHEMICAL
CORPORATION PROPOSED
DUETTE MINE
MANATEE COUNTY, FLORIDA

The ruderal vegetation comprised 2,257 additional acres, mainly improved pastures, row croplands, and citrus groves, also roadsides, ditches, and abandoned homesites. All stands of the natural communities showed at least some modifications from logging, cattle grazing, or an alteration of the natural frequency of fire.

The system of community classification used herein is adapted from three other systems. These are the classification of forest cover types by the Society of American Foresters (1954), the classification of wetland vegetation by the U.S. Fish and Wildlife Service (Shaw and Fredine, 1956), and the classification of cover types in Florida by the Division of State Planning (1976). Table 1-A is a concordance of these systems of classification.

2. LAND COMMUNITIES

Representative stands of the upland communities were visited throughout the property between August 23 and September 15, 1976. Lists of the plants and animals seen were kept for each community. These lists are not complete, owing to the single season of study, the limited time for investigations, the close grazing by cattle which likely obscured plants of some species, and the emphasis on studying communities of the land-water interface and the water.

Plant identifications were made using manuals by Small (1933), Radford et al. (1968), and Long and Lakela (1971). Animals were identified from manuals by Peterson (1947), Carr and Goin (1955), Conant (1958), Burt and Grossenheider (1964), Robbins et al. (1966), Cochran and Goin (1970, and Lowery (1974). Some identifications were made on the basis of calls, tracks, and fecal remains and others on direct sightings.

Table 1-A Concordance for Systems of Classification of Natural Communities.

EIS	Fla. Division of State Planning (1976)	Soc. Amer. For. (1954)	Shaw & Fredine (1956)
LAND			
Sand Pine Scrub	413. Sand Pine Scrub	69. Sand Pine	NA
Longleaf Pine-Xeric Oak	412. Longleaf Pine	71. Longleaf Pine-Scrub Oak	NA
Xeric Oak	421. Xeric Oak	72. Southern Scrub Oak	NA
Longleaf Pine Flatwoods	411. Pine Flatwoods	70. Longleaf Pine	NA
LAND-WATER INTERFACE			
Freshwater Swamp	621. Freshwater Swamp	104. Sweetbay-Swamp Tupelo-Red Maple	7. Wooded Swamps
Freshwater Marsh	641. Freshwater Marsh	NA	2. Inland Fresh Meadows 3. Inland Shallow Fresh Marshes
Cypress Swamp	611. Cypress	100. Pondcypress	7. Wooded Swamps
WATER			
Stream	511. Streams	NA	NA

NA = None Applicable

2.1 Sand Pine Scrub

Vegetation - Two stands of sand pine scrub occurred near the southern border of the property (Figure 1-1). Typical scrub species present included sand pine, rosemary, staggerbush, chapman oak, sand-live oak, myrtle oak, and tallow wood (Table 2.1-A). Scattered individuals of species typical of the longleaf pine-xeric oak community were also present, including longleaf pine and wiregrass. The earlier literature on the sand pine scrub community stated that these two communities were distinct. Later authors noted that the species of the sand pine scrub community have invaded adjacent stands of longleaf pine-xeric oak after the exclusion of fire for an extended period (Nash, 1895; Harper, 1915, 1921; Mulvania, 1931; Kurz, 1942; Laessle, 1967). It is presumed that the sand pine scrub community of the Swift property has expanded somewhat into adjacent areas of longleaf pine-xeric oak.

The sand pine scrub community occurs on well drained, sterile sands in Florida and in adjacent Mobile County, Alabama (Laessle, 1958; Fowells, 1965). The vegetation is characterized by an overstory of sand pines and a dense or at least thickety undergrowth of shrubs with coriaceous, evergreen leaves. Species richness is low, particularly in relation to adjacent longleaf pinelands. Grasses and forbs are sparse.

Climax Considerations- Most authors consider this community as a fire subclimax (Society of American Foresters, 1954; Veno, 1976), but Laessle (1958) emphasized that once established, the community persists indefinitely. The undergrowth is difficult to ignite and carries a fire poorly except under extraordinary conditions. As a result, scrubs burn under natural conditions once in the lifetime of a stand of sand pine (Harper, 1921), or about once every 50-75

Table 2.1-A Vascular Plants of the Sand Pine Scrub.

TREES

Pinus clausa
Sand pine
Pinus palustris
Longleaf pine

SHRUBS

Ceratiola ericoides
Rosemary
Lyonia fruticosa
Staggerbush
Lyonia lucida
Fetterbush
Quercus chapmanii
Chapman oak
Quercus geminata
Sand-live oak
Quercus myrtifolia
Myrtle oak
Serenoa repens
Saw-palmetto
Vaccinium myrsinites
Shiny-blueberry
Vaccinium stamineum
Florida blueberry
Ximenia americana
Tallow wood
Yucca flaccida
Beargrass

GRASSES

Andropogon (virginicus?)
Bluestem
Aristida stricta
Wiregrass
Aristida sp.
Three-awn
Panicum sp.
Panic grass

SEDGES, RUSHES

Bulbostylis ciliatifolia
Bulbostylis stenophylla
Bulbostylis warei
Bulbostylis
Cyperus nashii
Sedge
Rhynchospora megalocarpa
Beakrush

EPIPHYTES

Tillandsia recurvata
Ball moss
Tillandsia usneoides
Spanish moss
Tillandsia utricularia
Wild pine

FERNS

Selaginella arenicola
Spikemoss

COMPOSITES

Helenium angustifolium
Sneezeweed
Heterotheca graminifolia
Heterotheca tricophylla
Golden-aster
Palafoxia feayi
Palafoxia

LEGUMES

Chapmannia floridana
Alicia
Galactia volubilis
Milkpea

OTHER DICOTS

Helianthemum corymbosum
Rock-rose
Lechea cernua
Pinweed
Polygonella ciliata
Jointweed

years. The undergrowth is burned to the ground, but the individuals of most species coppice from their undamaged rootstocks, re-establishing the scrub directly. The pines are usually fire-killed. Most sand pines in peninsular Florida produce persistent serotinous cones, i.e., cones that remain closed for years. They open, releasing the seeds, only following exposure to the intense heat of fire. The resultant seedlings thrive, because they do not have to compete against a well developed undergrowth. The young pines quickly overtop the coppicing oaks and other scrub species. The entire community is re-established without any intervening seral stages.

On the Swift property and in other areas of west central Florida some of the sand pines produce open cones. Seedfall is not necessarily coincident with fire; therefore, fires may kill not only the pines but also any seeds and seedlings. Potentially, sand pines would be reduced in density or eliminated from the site following fire. Occasional stands of scrub occur in the region that lack sand pines and may owe their origin to this process (Garren, 1943). Sand pine may become restocked later if a seed source becomes available nearby and if site conditions remain favorable for successful germination. These observations suggest that the scrub undergrowth is the predominant feature of the community and that the sand pines, though conspicuous, are of secondary importance in scrub communities and are incidential to ecological processes that maintain scrubs.

Seral Trends - Laessle (1942, 1958) and Laessle and Monk (1961) showed that scrubs are slowly replaced by xeric southern mixed hardwood forest if fire is excluded indefinitely. The sterile dry sands and the competition from the well established undergrowth retard hardwood invasion. The water table is well beneath the soil surface in scrubs. Scrubs are absent from sites where the soils are saturated for more than a few days at a time. If regional water tables were lowered, there would likely be no effect on the scrub community. If regional water tables were raised to the point that soils remained saturated, it is likely that the scrub would be destroyed quickly and entirely. It would be replaced by a more mesic or hydric community. Scrubs are of low value for logging and grazing. Therefore, successional trends that might be initiated by these influences are seldom realized.

Fauna - The sand pine scrub is less productive of animal life than other communities of the Swift property. Food resources are limited largely to acorns, pine seeds, fruits of the tallow wood, insects, and twigs. The undergrowth provides some shelter to nonavian animals (Poppleton et al., 1972).

Animals seen in the scrub were gopher tortoise, six-line race runner, armadillo, ground dove, blue jay, and cattle egret. Several areas had been rooted by feral hogs. The burrows of gopher tortoises are known to provide shelter for other animals, which would otherwise by unable to survive the arid habitat of the scrub (Ernst and Barbour, 1972; Hartman, 1976). There is probably little interaction of consequence between the animals of the scrub and those of other habitats. The only animal utilized directly by man in the scrub is the feral hog.

2.2 Longleaf Pine - Xeric Oak

Vegetation - This community is represented on the property by one small stand near the southern boundary (Figure1-1). The overstory consisted solely of longleaf pine with a canopy closure of about 50-75%. The understory consisted primarily of turkey oak and sand-live oak. The undergrowth was primarily of wiregrass and other herbaceous species, including golden-asters, deer's-tongue, gopher apple, polygonella, and wing-stem. The species seen were the same as those of the Xeric Oak community (Table 2.2-A).

This community was once widespread in peninsular Florida, but because of clear cutting of the pine, much of it has been converted into the xeric oak community. Pines have not become restocked mainly for lack of a seed source.

Climax Considerations - This community experiences surface fires which were lightning-set about every 2-3 years under original conditions. Now they are mostly intentionally set by cattlemen and other land managers. The undergrowth consists almost entirely of long-lived perennial herbs and low shrubs which quickly resprout from their rootstocks following fire, much as grass resprouts after being mowed. Wiregrass is densely and evenly distributed and is the most important fuel for carrying fire over wide areas (Clewell, 1971).

Longleaf pine is the only tree in the Southeast capable of surviving fire at all stages of growth, including as a seedling (Wahlenberg, 1946). Trees of nearly all other species are excluded either by fire which kills their seedlings or by the sterile, often dry soil. Scrub oaks are exceptions. They survive most surface fires and readily coppice from their root crowns if intense fires kill their shoots.

They may have seeded-in during unusually prolonged fire-free periods and grew sufficiently to survive subsequent fires.

Paleonological data by Watts (1971), confirmed by Delcourt and Delcourt (1978), strongly suggest that longleaf pinelands became widespread at least 5,000 year ago and have persisted without modification to the present. The stability of longleaf pinelands led Chapman (1932) and Clewell (1971, 1978) to consider them as a climax community. This view presupposes that lightning is a natural climatic phenomenon like temperature and precipitation and the lightning-set fires are proportional to the frequency of thunderstorm days per year (Komarek, 1966). Most authors consider longleaf pine communities merely as fire subclimaxes and believe that longleaf pinelands would be replaced by a true climax of mixed hardwoods in the absence of fire. This tendency towards hardwood invasion is well documented (e.g., Beckwith, 1967) but occurs only where man has suppressed fire.

The longleaf pine-xeric oak community reaches its southern-most limit of distribution in west-central Florida. Throughout most of the Southeast the principal oak in this community is turkey oak. In west-central Florida sand-live oak is also an important species. Chapman oak, myrtle oak, and scrub palmetto may also be intermixed, as they are on the Swift property. All but turkey oak are generally considered as components of the sand pine scrub community, rather than of longleaf pinelands. This mixture of oaks at the southern end of the range of the longleaf pine-xeric oak community has not been explained by previous investigators. There is some evidence that fire suppression in previous decades allowed the invasion of oaks from adjacent sand pine scrub communities. The predominance of these oaks, though, suggests that fire suppression alone is an inadequate explanation. These oaks might be relictual from times when scrub communities were much more widespread in Florida (Watts, 1971).

Seral Trends - Once logged, the pines may not return, at least in numbers. Even with the availability of seed trees, restocking is retarded because of erratic seeding, the requirement of a fire immediately preceding seedfall for seed bed preparation, and the infrequency of favorable moisture conditions (Wahlenberg, 1946).

Logging operations that do not scarify the soil have no effect on species composition of the undergrowth. The oaks increase somewhat in density in the absence of competition from pines, but this change is of minor consequence ecologically (Stoddard, 1931; Pessin, 1933). The 50-75 species that comprise this undergrowth persist indefinitely without change, as has been witnessed throughout much of peninsular Florida on longleaf pinelands that were logged 50-100 years ago.

The sparcity of favorable forage grasses precludes the possibility of heavy cattle grazing and thus any adverse effects by grazing on the vegetation.

A reduction in the frequency of fire causes a modest increase in oaks and other woody components of the undergrowth at the expense of the herbaceous plants. Species composition is not affected. Prolonged fire exclusion allows the invasion of the fire-sensitive but highly competitive species of the sand pine scrub community. A drop in the level of the regional water table will have no major consequence. A rise in the water table would allow the more important species from the longleaf pine flatwoods community to increase in abundance. Most of these species are already present in the longleaf pine-xeric oak community in low numbers.

Soil disturbance by such agencies as plowing, disking, and chopping, reduces or eliminates wiregrass (Woods, 1959). Once destroyed, wiregrass does not return, regardless of time, site conditions, or the availability of potential seed sources (Loughridge, 1884; Wells and Shunk, 1931; Hebb, 1957; Clewell, 1971, 1978). Seeds are rarely produced, and sexual reproduction is negligible (Parrott, 1967). Certain other species associated with wiregrass are also reduced or eliminated and seem unable to return (Wells and Shunk, 1931). Among these are some of the more common species, such as the runner oaks, dwarf blueberry, palmetto, and turkey oak. These species have wildlife food value, particularly in winter when food is scarce (Hebb, 1971; Clewell, 1978). Other species which were once absent, uncommon, or stunted become dominant, including broomsedge, blackberry, panic grass, golden-aster, and dog-fennel (Harris et al., 1974). The total number of species is reduced upon severe soil disturbance, and the number of abundant or dominant species declines. The vegetation predominating after soil disturbance is of reduced flammability. The frequency of fire is often diminished, at least somewhat, allowing the invasion of trees and shrubs. Longleaf pine is not among them because of its requirements for an open seed bed and its sensitivity to competition from woody species (Wahlenberg, 1946). The direction of succession depends on site conditions. The tendency is towards hardwood forest or, if fire is frequent, towards an open woodland. The longleaf pineland does not return.

Fauna - Since the longleaf pine-xeric oak community is poorly represented on the Swift property, and because there is scarcely any ecological difference between this community and the xeric oak community, the details of the fauna are applicable to both communities and will be treated under the xeric oak community.

2.3 Xeric Oak

Vegetation - This community is dominated by sand-live oak and/or turkey oak, depending upon the location. These small shrubby oaks have a canopy closure of about 50%. Other woody growth includes saw-palmetto, fetterbush, staggerbush, Chapman oak, tallow wood, and scrub palmetto. Wiregrass and many other herbs form the rather dense ground cover. Table 2.2-A lists the species seen on the Swift property. Longleaf pine stumps were common throughout, which is proof that the Xeric Oak community was derived secondarily by the removal of these pines by clear cutting. The abundance of saw-palmetto and fetterbush suggests that part of this community may have been cutover longleaf pine flatwoods.

Climax Considerations - This community consists of a mixture of those species surviving logging of the longleaf pinelands. The community is apparently stable, in spite of the lack of pines, and can be considered either as a climax or fire subclimax for the same reasons as were offered for the longleaf pine-xeric oak community.

Seral Trends - This community could be replanted to longleaf pine and burned, thereby reestablishing the original vegetation. Other seral trends are those listed for the longleaf pine-xeric oak and longleaf pine flatwoods communities.

Fauna - Animals seen on the Swift property in the xeric oak community were gopher tortoise, scrub jay, blue jay, ground dove, mourning dove, rufous-sided towhee, and armadillo. Although mammal trapping was not included in the field investigations, a thorough search for

Table 2.2-A Vascular Plants of the Xeric Oak Community

TREES

Pinus clausa	Sand pine
Pinus palustris	Longleaf pine
Quercus laevis	Turkey oak
Quercus laurifolia X laevis	Oak hybrid

SHRUBS, WOODY VINES

Licania michauxii	Gopher-apple
Lyonia fruticosa	Fetterbush
Opuntia sp.	Prickly pear
Quercus chapmanii	Chapman oak
Quercus geminata[1]	Sand-live oak
Quercus myrtifolia	Myrtle oak
Sabal etonia	Scrub palmetto
Smilax auriculata	Greenbrier
Smilax pumila	Dwarfbrier
Ximenia americana	Tallow wood

GRASSES

Andropogon spp.[2]	Bluestem
Aristida stricta	Wiregrass
Panicum rhizomatum	Panic grass
Panicum sp.	Panic grass
Paspalum setaceum	Paspalum

SEDGES, RUSHES

Bulbostylis ciliatifolia	Bulbostylis
Bulbostylis warei	Bulbostylis
Cyperus sp.	Sedge
Rhynchospora megalocarpa	Beakrush

EPIPHYTES

Encyclia tampensis	Florida butterfly orchid
Polypodium polypodioides	Resurrection fern
Tillandsia recurvata	Ball moss
Tillandsia usneiodes	Spanish moss
Tillandsia utricularia	Wild pine

COMPOSITES

Aster adnatus	Aster
Carphephorus odoratissimus	Deer's-tongue
Heterotheca trichophylla	Golden-aster
Pterocaulon pycnostachyum	Wingstem

LEGUMES

Chapmannia floridana	Alicia
Galactia volubilis	Milkpea

OTHER DICOTS

Cnidoscolus stimulosus	Tread-softly
Helianthemum corymbosum	Rock-rose
Lechea cernua	Pinweed
Portulaca pilosa	Rose-purselane

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[1] A few approaching tree height.

[2] Probably including *Andropogon virginicus*.

animals was made. It can only be concluded that the Xeric Oak community is species-poor faunistically. Perhaps the uniformity of habitat and the lack of cover for birds and larger mammals contributed to the paucity of the fauna.

Animals that would be expected but were not seen were the oak toad, gopher frog, six-lined race runner, Florida mouse, old field mouse, golden mouse, and Florida skink (Rand and Host, 1942; Dickerson, 1969; Cockran and Goin, 1970; Hartman, 1976). Gopher tortoise burrows were more abundant in the Xeric Oak community than in any other habitat on the Swift property. Golden mice tend towards arboreal habits and should occur in areas with larger sand-live oaks (Rand and Host, 1942; Lowery, 1974).

Xeric oak scrub is a breeding area for many of the species found there, such as the old field mouse and gopher tortoise. Several of the species found there, such as the doves, breed both in the xeric oak and in other habitats. The amphibians breed in wet areas. Scrub jays nest in xeric oak and sand pine scrub but nowhere else (Harrison, 1975).

Flatwoods animals may enter the oak scrub on an intermittent basis for food and shelter, and species characteristic of xeric oak may spend part of their time in other habitats.

Animals occupying the xeric oak, which are of potential use to man, are the feral hog and mourning dove.

2.4 Longleaf Pine Flatwoods

Vegetation - The overstory consisted of an open stand of longleaf pine on the higher sites. Some slash pines were intermixed on the lower, wetter sites. Extensive logging had reduced the canopy closure to less than 10 percent. Table 2.4-A lists the species of plants seen in the longleaf pine flatwoods community on the Swift property. Important in the dense undergrowth were gallberry, saw-palmetto, fetterbush, wax-myrtle, blueberry, runner oak, wiregrass, and many other herbaceous species, particularly grasses and composites.

Longleaf pine flatwoods generally surround the fresh water marshes on the Swift property. These communities are sharply defined by the presence or absence of wiregrass, saw-palmetto, gallberry, wax-myrtle, and their associated species. Wiregrass is intolerant of a hydroperiod of more than about 114 days (Parrott, 1967). Most other flatwoods species tend to grow only with wiregrass. Therefore, the flatwoods and the marshes are rather distinct, even though several species are common to both communities. The flatwoods tend to be more shrubby near the marshes, probably because of increased moisture and less flammable conditions.

Climax Considerations - The statement on climax for the longleaf pine-xeric oak community is also applicable to this community.

Seral Trends - It is generally assumed that any longleaf pineland that is kept fire-free indefinitely will succeed to a southern mixed hardwoods forest (Monk, 1968; Veno, 1976). The infertility of the soil, though, greatly slows this process. Logging grazing, or destructive fire regularly interrupt this process

Table 2.4-A Vascular Plants of the Longleaf Pine Flatwoods.

TREES

Pinus elliottii
Slash pine
Pinus palustris
Longleaf pine

SHRUBS

Asimina reticulata
Dog-apple
Hypericum cistifolium
St. John's-wort
Hypericum myrtifolium
St. John's-wort
Hypericum tetrapetalum
St. John's-wort
Ilex glabra
Gallberry
Licania michauxii
Gopher-apple
Lyonia fruticosa
Staggerbush
Lyonia lucida
Fetterbush
Myrica cerifera
Wax-myrtle
Pyrus arbutifolia
Red chokeberry
Quercus geminata
Sand-live oak
Quercus pumila
Runner oak
Quercus minima
Dwarf-live oak
Rhus copallina
Winged sumac
Rubus cuneifolius
Blackberry
Serenoa repens
Saw-palmetto
Stillengia sylvatica
Queen's delight
Vaccinium myrsinites
Blueberry
Yucca flaccida
Beargrass

WOODY VINES

Scranbria microphylla
Sensitive-brier
Smilax auriculata
Smilax glanca
Greenbrier

GRASSES

Andropogon spp.[1]
Bluestem
Aristida spiciformis
Three-awn
Aristida stricta
Wiregrass
Aristida sp.
Three-awn
Axonopus (furcatus?)
Carpet grass
Panicum verrucosum
Panicum sp.
Panic grass
Paspalum praecox
Paspalum spp.
Paspalum

SEDGES, RUSHES

Cyperus sp.
Sedge
Eleocharis baldwinii
Spikerush
Fimbristylis (dichotoma?)
Fringe rush
Juncus spp.
Rushes
Rhynchospora (fascicularis?)
Beakrush
Scleria ciliata
Nut rush

EPIPHYTES

Tillandsia recurvata
Ball moss
Tillandsia usneoides
Spanish moss
Tillandsia utriculata
Wild pine

---

[1] Probably *Andropogon stolonifer* and *A. virginicus*.

Table 2.4-A Continued

OTHER MONOCOTS

Cuthbertia ornata
Roselings
Hypoxis juncea
Star grass
Lachnocaulon sp.
Bog buttons
Lilium catesbaei
Pine lily
Spiranthes sp.
Ladies tresses
Xyris spp.
Yellow-eyed grass

COMPOSITES

Aster bifoliatus
White topped aster
Carphephorus odoratissimus
Deer's-tongue
Elephantopus sp.
Elephant's foot
Erigeron vernus
Fleabane
Eupatorium recurvans
Thoroughwort
Helianthus simulans
Sunflower
Liatris sp.
Blazing star
Lygodesmia aphylla
Roseling
Pterocaulon pycnostachyum
Wingstem
Solidago microcephala
Goldenrod
Solidago sp.

LEGUMES

Chapmannia floridana
Alicia
Galactia elliottii
Milk-pea

OTHER DICOTS

Agalinis sp.
False foxgloves
Asclepias connivens
Milkweed
Asclepias pedicellata
Milkweed
Buchnera floridana
Bluehearts
Centella asiatica
Coinwort
Hedyotis sp.
Innocence
Helianthemum corymbosum
Rock rose
Hyptis alata
Musky mint
Ludwigia arcuata
Seedbox
Ludwigia hirta
Seedbox
Polygala rugelii
Milkwort
Polygonella fimbriata
Jointweed
Polypremum procumbens
Polypremum
Rhexia mariana
Meadow-beauty
Rhexia nuttallii
Meadow-beauty
Sabatia brevifolia
Marsh pink

before the hardwoods become well established.

Disturbance of the soil will severely modify the undergrowth, as was discussed for the longleaf pine-xeric oak community. Saw-palmetto, if removed, becomes reestablished very slowly if at all (Clewell, 1971).

If regional water tables are lowered, there may be a gradual increase in density of those species shared in common with the longleaf pine-xeric oak community. The pines would not be affected, and this vegetational change would be inconsequential. If regional water tables were raised, the lower sites would likely be converted quickly into fresh water marsh.

Fauna -Species seen in the flatwoods include the feral hog, mourning dove, bobwhite quail, cottontail, red fox, opossum, and deer, all of which are useful to man. Other animals that are common in pine flatwoods include the southern toad, tree frogs, glass lizard, diamondback rattlesnake, wild turkey, grey squirrel, fox squirrel, skunk, cotton rat, least shrew, and harvest mouse (Rand and Host, 1942; Poppleton et al., 1972; Layne, 1974). Loss of the pines on the Swift property reduced the habitat for aboreal species, such as perching birds, tree frogs, and squirrels.

2.5 Ruderal Habitats

Vegetation -The more disturbed areas contained a variety of weedy plants. Some of the more common species are listed in Table 2.5-A. Intentionally introduced species include orange, bahia grass, tomato, and watermelon. The pasture lands have been improved to various

Table 2.5-A Plants of Ruderal Areas.

TREES SHRUBS

Baccharis halimifolia
Saltbush
Citrus sinensis
Sweet orange
Clerodendron indica
Glory bower
Lantana comosa
Lantana
Myrica cerifera
Wax-myrtle
Pisidium guajava
Guava
Sambucus canadensis
Elderberry

GRASSES

Andropogon spp.
Broomsedge
Cenchrus spp.
Sandspurs
Digitaria spp.
Crabgrass
Echinochloa colonum
Echinochloa walteri
Wild millet
Eleusine indica
Yardgrass
Paspalum notatum
Bahia
Paspalum urvillei
Vasey grass

OTHER MONOCOTS

Cyperus spp.
Sedges
Juncus spp.
Rush
Murdannia nudiflora
Murdannia

COMPOSITES

Acanthospermum hispidum
Acanthospermum
Bidens leucantha
Spanish needles
Cirsium horridulum
Thistle
Coreopsis leavenworthii
Tickseed
Erigeron canadensis
Horseweed
Eupatorium capillifolium
Dogfennel

OTHER DICOTS

Chamaesyce spp.
Spurge
Citrullus vulgaris
Watermelon
Crotalaria spectabilis
Rattlebox
Desmodium spp.
Beggar's ticks
Lespedeza striata
Korean clover
Lippia nodiflora
Cape weed
Ludwigia peruviana
Willow primrose
Lycopersicon esculentum
Tomato
Solanum ciliatum
Soda apple

degrees by land clearing and the seeding of bahia. In many places the native vegetation has become partially reestablished.

Fauna- No non-domestic animals live or breed exclusively in ruderal areas. Several are seen commonly in such areas, though. Among them are the black racer, armadillo, opossum, cotton rat, house rat, and Norway rat. The red fox, which was introduced widely in Florida, is often seen in fields (Naggair, 1976a). One was recorded dead on State Road 62 at Duette during the time of this survey. The least shrew primarily inhabits old broomsedge fields (Golley, 1962). Birds seen commonly in ruderal areas of the Swift property were the kestrel, cattle egret, sandhill crane, common crow, meadow lark, and killdeer. Less common species were bobwhite quail and mourning dove. Burrowing owls were seen on ruderal sites on the adjacent Turner Ranch. Many animals breed in ruderal habitats, especially small mammals and ground-nesting birds. The ruderal habitats contain wildlife food plants, including cultivated crops like corn. The exploitation of these food sources by animals of nearby natural habitats represents an interaction between ruderal and native communities.

3. LAND-WATER INTERFACE COMMUNITIES

Communities of the land-water interface were inventoried between August 23 and September 15, 1976. The fresh water swamp community was sampled at six widely spaced locations by the quarter-point method (Phillips, 1959). At each location, 30 sampling points were established at 10 meter intervals along transects running perpendicularly from the river bank to the edge of the upland. The transects at each location were parallel to each other and were spaced 20 meters apart. Trees of at least 4 inches in diameter were tallied and measured for diameter breast height (dbh). Only the largest stem was recorded for a tree with multiple trunks. From these data were calculated the total number of trees per acre and per hectare, the relative dominance (percent basal area) of each species, the relative density (percent composition) of each species, and the relative frequency (percent frequency) of each species. An importance value for each species was calculated by adding the values for relative dominance, relative density, and relative frequency.

The only cypress swamp on the property was inventoried in a similar manner at 15 sampling points.

Three fresh water marshes in pineland depressions were sampled for frequency and percent cover in 31 1-meter^2 quadrats spaced 50 meters apart on transect lines beginning at the center of each marsh and running to the periphery.

Check lists of plants and animals were prepared for each community. Aquatic animals were collected by dip net and by a 4-by-25-foot bag seine. Specimens were fixed in 10 percent formalin and transferred to 40 percent isopropyl alcohol for storage. Identifications were based on keys and descriptions by Small (1933), Carr and Goin (1955), Edmondson (1959), Radford et al. (1968), Eddy (1969), and Long and Lakela (1971).

3.1 Fresh Water Swamp

Vegetation - This community occurred as dense stands of hardwoods bordering streams and headwaters. Along streams the community formed a narrow strip of vegetation near the stream channels. At the headwaters the flow was not channelized. Such areas are often called "bayheads". Canopy closure approached 100 percent. Table 3.1-A summarizes the arboreal flora. Laurel oak is clearly the most important tree. Red maple and swamp tupelo are the next most important species, and Carolina ash is important for its high density. Stumps of slash pine indicated that this tree was once more prevalent than it is today. The restocking of slash pine appears to be limited to areas where the canopy is broken, allowing sunlight to reach the ground. Plants of the non-arboreal species were rather sparse, owing to the shade from the canopy. Many of these species are listed in Table 3.1-B. The last seven species listed in Table 3.1-A were more common in the undergrowth than in the canopy. The shrubs sometimes formed small thickets, particularly in the bayheads. Epiphytes were conspicuous and included two orchids, *Encyclia tampensis* and *Harrisella porrecta*.

Table 3.1-A Fresh Water Swamp Overstory (Defined as Trees of at least 4 Inches in Diameter).

	Relative Dominance	Relative Density	Relative Frequency	Importance Value
Quercus laurifolia Laurel oak	49	29	23	101
Acer rubrum Red maple	13	13	14	40
Nyssa biflora Swamp tupelo	11	10	12	33
Ulmus americana American elm	9	5	6	20
Fraxinus caroliniana Carolina ash	8	18	16	42
Magnolia virginiana Sweetbay	4	6	7	17
Ilex cassine Dahoon	2	6	7	15
Quercus virginiana Live oak	2	2	2	6
Pinus elliottii Slash pine	1	1	1	3
Persea palustris Swamp bay	1	1	1	3
Cornus foemina Blue dogwood	-	5	6	11
Carpinus caroliniana American hornbeam	-	1	2	3
Viburnum obovatum Walter's viburnum	-	2	2	4
Cephalanthus occidentalis Buttonbush	-	1	1	2
Myrica cerifera Wax myrtle	-	-	-	-
Styrax americana Storax	-	-	-	-
Diospyros virgninana Persimmon	-	-	-	-
TOTAL	100	100	100	300

Total Number of Trees: 79/ha or 196/acre.
Total Basal Area: 18.5 m^2/ha or 491 ft^2/acre.

Overstory species not included in the samples: *Fraxinus profunda* (pumpkin ash), *Gordonia lasianthus* (loblolly bay), *Liquidambar styraciflua* (sweetgum), and *Sabal palmetto* (cabbage palm).

Table 3.1-B Non-arboreal Plants of the Fresh Water Swamp Community.

SHRUBS

Bumelia reclinata	Tough bumelia
Citrus sinensis	Sweet orange
Hypericum hypericoides	St. John's-wort
Itea virginica	Virginia willow
Rhododendron viscosum	Swamp honeysuckle
Sabal minor	Blue palm
Serenoa repens	Saw-palmetto
Vaccinium fuscatum	Blueberry
Viburnum cassinoides	Viburnum

WOODY VINES

Ampelopsis arborea	Peppervine
Gelsemium sempervirens	Yellow jasamine
Parthenocissus quinquefolia	Virginia creeper
Smilax bona-nox	Greenbrier
Toxicodendron radicans	Poison ivy
Vitis aestivalis	Autumn grape
Vitis rotundifolia	Muscadine

EPIPHYTES

Encyclia tampensis	Florida butterfly orchid
Harrisella porrecta	Harrisella orchid
Polypodium polypodioides	Resurrection fern
Tillandsia fasciculata	Cardinal wildpine
Tillandsia recurvata	Ball moss
Tillandsia setacea	Needle-leaved wildpine
Tillandsia usneoides	Spanish moss
Tillandsia utriculata	Giant wildpine

TERRESTRIAL FERNS, MOSSES

Osmunda cinnamomea	Cinnamon fern
Osmunda regalis	Royal fern
Sphagnum sp.	Sphagnum moss
Thelypteris dentata	Marsh fern
Thelypteris interrupta	Marsh fern
Woodwardia areolata	Net-veined chain-fern
Woodwardia virginica	Virginia chain-fern

TERRESTRIAL MONOCOTS

Arisaema triphyllum	Jack-in-the-pulpit
Axonopus sp.	Carpetgrass
Cyperus sp.	Sedge
Habenaria repens	Water-spider orchid
Hymenocallis crassifolia	Spider lily
Hypoxis hirsuta	Star grass
Panicum (anceps?)	Panic grass
Pontederia lanceolata	Pickerelweed
Rhynchospora miliacea	Beakrush

Table 3.1-B Continued.

TERRESTRIAL DICOTS

Asclepias perennis
Milkweed
Bacopa monnieri
Bacopa
Centella asiatica
Coinwort
Clematis crispa
Leather flower
Desmodium sp.
Beggar's ticks
Dichondra caroliniensis
False pennywort
Drymaria cordata
West Indian chickweed
Eupatorium coelestinum
Mistflower
Lindernia crustacea
Lindernia grandiflora
False pimpernal
Ludwigia alata
Evening primrose
Mitchella repens
Partridge berry
Polygonum (punctatum?)
Knotweed
Samolus parviflorus
False pimpernal
Saururus cernuus
Lizard's tail
Solanum ciliatum
Soda apple
Viola floridana
Violet

There was a tendency for the forests of the bayheads to differ in composition somewhat from forests along streams, but similarities and the intergradation between these forests precluded their being treated as distinct communities. In general, the forests of the bayheads tended to be characterized by the following species: sweetbay, swampbay, loblolly bay, slash pine, viburnum, blueberry, sphagnum moss, and lizard's tail, more so than in forests along defined channels.

Pumpkin ash (*Fraxinus profunda*) reaches its southernmost limit of distribution at the proposed mine site. It was reported as far south as Marion County (Little, 1977) and Hillsborough and Polk counties (A. G. Shuey, personal communication, 1978).

Climax Considerations - The fresh water swamp community represents the hydric phase of the southern mixed hardwoods forest climax (Monk, 1968). This community is stable and presumably would persist indefinitely under present conditions.

Seral Trends - Following logging, slash pines would likely be important in the regrowth. Many of the hardwoods would resprout from their stumps and others would seed-in, without much change in species composition. A lowering of regional water tables would cause a gradual change in forest composition favoring more xeric hardwoods over the more hydric hardwoods. Fires may be more frequent, which would favor an increase in slash pines. Fire would also open the canopy somewhat and eliminate some of the more fire-tender hardwoods. There would not be enough fuel to cause a destructive crown fire, or if there were, restocking would follow the pattern predicted above for logging.

A rise in regional water tables would cause flooding in the lower areas during the summer. Only swamp tupelo could survive such flooding (Penfound and Hathaway, 1938; Dickson et al., 1965; Kennedy 1970; Clewell, 1971). If a dam or other structure were installed to minimize flooding, the species composition would remain constant but productivity would be reduced for lack of seasonal flood surges that carry nutrients. Lack of flooding would allow peat to accumulate, lowering the pH and favoring the species of bayheads, such as sweetbay, swampbay, and swamp tupelo. If sedimentation would increase, many trees would die and most others would suffer crown damage until new roots were produced in these sediments. Red maple, which sprouts new roots quickly, would increase in importance at the expense of the other species that are less tolerant of sedimentation (Clewell and McAninch, 1977).

Fauna - Animals that were identified in the fresh water swamp community on the Swift property were the indigo snake, raccoon, feral hog, grey fox, and cotton mouse. Toads and tadpoles were seen. Other animals that have been observed in this type of community elsewhere in Manatee and surrounding counties are: short-tailed shrew, marsh rabbit, river otter, opossum, grey squirrel, bobcat, long-tailed weasel, American alligator, wood duck, barred owl, redbellied woodpecker, blue-grey gnatcatcher, eastern bluebird, and others, including many species of migratory birds (Cowell et al., 1974).

Animals of use to man include the feral hog, raccoon, opossum, grey squirrel, grey fox, otter, bobcat, marsh rabbit, wood duck, indigo snake, and American alligator.

Functions - Fresh water swamps filter sediments that otherwise would wash into the streams by sheet erosion. The shade from the canopy keeps the water of the stream cool. Some of the nutrients released from the decomposition of forest litter enter the stream and increase aquatic productivity. Shade, cool temperatures, and nutrients help determine species composition and productivity in the streams. Animals of upland habitats utilize swamps for protection, e.g., the bobwhite quail (Stoddard, 1931).

3.2 Fresh Water Marsh

Vegetation - Shallow temporary ponds with emergent marsh vegetation are scattered throughout the Swift property. These ponds are merely catch-basins receiving surface runoff during wet seasons. Maximum depths are about 2-2.5 feet. The water table drops just below the soil surface during the dry season in years with near-normal rainfall, except in the deepest portions where floating-leaved aquatics grow. Even these deep areas dry out in years of subnormal precipitation.

Table 3.2-A gives the percent cover and frequency of the plants growing in three marshes. Table 3.2-B lists the species of the only marsh on the Swift property that is surrounded by cypress.

The marshes exhibited vegetational zonation with respect to water depth. The deeper water towards the center of the marshes contained St. John's-wort (Hypericum fasciculatum), creeping rush, mermaid weed, floating hearts, sphagnum moss, species of Ludwigia and Sagittaria, pickerelweed, and sawgrass. The shallower edges supported coinwort, spikerush, broomsedge, yellow-eyed grass,

Table 3.2-A Percent Cover and Frequency of Plants from Three Marshes, based on 31, Meter^2 Quadrats.

	% Cover	Frequency
Grasses		
Andropogon spp. (Broomsedge)	5	.36
Aristida purpurascens (Arrowfeather)	2	.13
Aristida spiciformis (Bottlebrush three-awn)	1	.07
Axonopus (furcatus?) (Carpetgrass)	2	.07
Panicum hemitomon (Maidencane)	2	.29
Panicum tenerum	-	.10
Panicum (lancearium?)	1	.45
Paspalum laeve	2	.29
Spartina bakeri (Cordgrass)	1	.03
Unidentified grasses	2	.19
Sedges, Rushes		
Eleocharis baldwinii (Spikerush)	5	.29
Eleocharis sp.	1	.26
Fuirena scirpoides (Umbrella grass)	-	.10
Juncus repens (Creeping rush)	32	.42
Rhynchospora (fascicularis?, schoenoides?) (Beakrush)	2	.42
Scleria (reticularis?)	1	.13
Ferns, Mosses		
Lycopodium adpressum (Clubmoss)	-	.03
Sphagnum stricta (Sphagnum)	1	.42

Table 3.2-A Continued.

	% Cover	Frequency
Other Monocots		
Aletris aurea (Colic root)	-	.03
Eriocaulon sp. (Hatpin)	1	.03
Lachnanthes caroliniana (Redroot)	-	.03
Lachnocaulon sp. (Bog buttons)	4	.23
Pontederia lanceolata (Pickerelweed)	-	.03
Sagittaria isoetiformis (Duck potato)	1	.23
Xyris platylepis, X. (elliottii?) (Yellow-eyed grass)	1	.42
Shrubs		
Hypericum fasciculatum (St. John's-wort)	13	.48
Hypericum myrtifolium	1	.29
Composites		
Bigelowia nudata (Rayless goldenrod)	-	.10
Carphephorus odoratissimus (Deer's tongue)	-	.03
Eupatorium recurvans (Throughwort)	1	.13
Pluchea rosea (Marsh fleabane)	-	.10
Solidago microcephala	1	.07
Other Dicots		
Centella asiatica (Coinwort)	12	.39
Gratiola ramosa (Hedge hyssop)	1	.23
Hydrocotyle umbellata (Marsh pennywort)	-	.10

Table 3.2-A Concluded

	% Cover	Frequency
Other Dicots Continued		
Ludwigia palustris (Evening primrose)	1	.29
Ludwigia suffruticosa	1	.29
Nymphoides aquatica (Floating hearts)	-	.03
Polygala rugelii (Milkwort)	-	.10
Polygonum persicaria (Knotweed)	1	.03
Proserpinaca pinnata (Mermaidweed)	-	.19
Sabatia difformis (Marsh pink)	-	.03

Other marsh species not occurring in quadrats: *Cladium jamaicense* (sawgrass), *Dichromena latifolia* (white-top), *Cephalanthus occidentalis* (buttonbush), *Ilex cassine* (dahoon), *Ilex glabra* (gallberry), *Myrica cerifera* (wax-myrtle), *Oxypolis filiformis* (dropwort).

Table 3.2-B Flora of the Marsh in the Cypress Pond.

Grasses	
Amphicarpum purshii	Amphicarpum
Andropogon spp.	Broomsedge
Panicum hemitomon	Maidencane
Sedges, Rushes	
Cyperus sp.	Sedge
Eleocharis baldwinii	Spikerush
Fuirena scirpoides	Umbrella grass
Other Monocots	
Pontederia lanceolata	Pickerel weed
Sagittaria isoetiformis	Duck potato
Shrubs	
Hypericum myrtifolium	St. John's-wort
Composites	
Eupatorium capillifolium	Dog-fennel
Pluchea rosea	Marsh fleabane
Other Dicots	
Centella asiatica	Coinwort
Hydrocotyle umbellata	Marsh pennywort
Ludwigia suffruticosa	Evening primrose
Ludwigia pilosa	Evening primrose
Lycopus rubellus	Water hoarhound
Polygonum persicaria	Knotweed
Rhexia mariana	Meadow-beauty
Utricularia purpurascens	Bladderwort

pennywort, and many others. Small thickets of shrubs were scattered about, mainly occupying slightly elevated spots within the marsh.

Between marshes there was considerable variation in dominance and to a much lesser extent, species composition. The marsh surrounded by cypress was dominated by maidencane. Pickerelweed and knotweed were also common. The other three marshes under consideration contained conspicuous growths of St. John's-wort centrally. Creeping rush was the predominant species in the shallower portions of two of these marshes, and the third marsh was characterized more by yellow-eyed grass and coinwort.

Marshes such as these are locally called prairies or swales. According to the classification of wetlands by Shaw and Fredine (1956) the marsh surrounded by cypress would be an Inland Shallow Fresh Marsh, and all other marshes would be Inland Fresh Meadows. According to the classification by Cowardin et al. (1976) all marshes on the Swift property are Palustrine, Emergent, Fresh Water Wetlands, Seasonally to Semipermanently Flooded.

Climax Considerations - Although fresh water marshes are not generally considered as representing climax communities, the marshes on the Swift property are stable and may persist indefinitely under present environmental conditions. The marsh habitats are too dry part of the year to support aquatic vegetation and too wet most of the year to favor upland vegetation. Woody hydrophytes such as buttonbush and dahoon would be expected to replace the herbaceous growth, but these woody species are restricted by prolonged flooding during the summer and by frequent fires. The fires sweep across the adjacent pine flatwoods every few years and ignite the marsh grasses. The tops of the emergent marsh plants will burn and carry a fire, even if there is standing water present.

Seral Trends - In the absence of fire, the marshes eventually would be overtaken by hardwood swamp species, primarily those that could tolerate prolonged flooding and concomittant anaerobic conditions during the summer. If the regional water table were to be raised, the emergent marsh vegetation would be replaced by submersed aquatics. If the water table were lowered, it is likely that broomsedge and perhaps slash pine would become established as a dominant species. Wiregrass, palmetto, and other dominants of the undergrowth in the pine flatwoods have low reproductive potentials and would not be expected to invade the site. The broomsedge community would persist if fire were frequent. Otherwise, succession would lead to a southern mixed hardwood forest which would include live oak.

A different type of vegetation on the site may have a profound effect on evapotranspiration and therefore the water table. A mixed hardwood forest may lower the water table in the summer by several feet (Trousdel and Hoover, 1955), or the removal of pines from the surrounding uplands may prolong the hydroperiod (Pessin, 1933; Clewell, 1971).

The marshes are already moderately to heavily grazed by cattle. Grazing reduces the total biomass and causes shifts in the relative biomass between species, but it does not affect species composition. Therefore, grazing does not initiate successional changes in the vegetation.

Fauna - Birds comprise the largest group of vertebrates utilizing the marshes. Observed were the great blue heron, little blue heron, cattle egret, green heron, Louisiana heron, common egret, white ibis, wood stork, sand-hill crane, belted kingfisher, red-winged blackbird, brown-headed cowbird, and pied-billed grebe. One flock of white ibis consisted of more than 200 individuals.

Common vertebrate animals of central Florida marshes also include mosquitofish, least killifish, golden topminnow, pygmy sunfish, leopard frog, little grass frog, chorus frog, cricket frog, mud turtle, musk turtles, American alligator, rice rat, Florida water rat, and marsh rabbit. Raccoons are attracted to the abundant crayfish. Feral hogs root about along the edges of the marshes.

The marshes serve as breeding and feeding areas for numerous species. Most frogs and toads of the region breed in flatwoods ponds and marshes (Conant, 1958; Cochran and Goin, 1970). The larger wading birds nest in trees but require marshes for feeding areas (Harrison, 1975; Reilly, 1968). The red-winged blackbird, pied-billed grebe, sandhill crane, and other birds nest in and near the marshes (Burleigh, 1958; Harrison, 1975). Useful animals include the raccoon, feral hog, and marsh rabbit.

Functions - The marshes serve as water storage areas. With the advent of dry seasons, lateral seepage maintains soil moisture in the surrounding pine flatwoods. Animals that are largely confined to other habitats may depend on marshes for water in dry seasons. Marshes are productive habitats which are exploited by many species of animals, including large wading birds which depend on marshes for food.

3.3 Cypress Swamp

Vegetation - Only one stand of cypress (18 acres) occurred on the Swift property (Figure 1-1). The flora of this swamp is presented in Table 3.3-B. The overstory consisted solely of pondcypress. The density of the overstory trees was 1,340 per acre (3,310/ha). The basal area of these trees was 272 ft^2 per acre (62.4 m^2/ha). Spanish moss and ball moss were common epiphytes.

The understory was sparse and consisted of shrubs and small trees. These woody plants mostly grew on top of rotting cypress stumps just above the high water mark. Others grew alongside of cypress trees, where organic debris had accumulated. Herbs also utilized these elevated sites. Herbaceous growth was plentiful where openings in the canopy allowed light to enter. The more shaded areas contained scattered plants of marsh and serpent ferns and a dense floating mat of liverworts. Hypericum virginicum, recorded in the cypress swamp, heretofore was unknown from Manatee County.

Climax Considerations - Cypress swamps are usually not considered to represent climax vegetation, even though they are persistent and may remain stable for millenia. It is thought that peat will accumulate eventually to the point that hydric hardwoods are able to replace the cypress (Brown and Monk, 1965). On the other hand, deep burning peat fires may ignite during prolonged droughts, killing the cypress and causing the formation of ponds upon the

Table 3.3-A Plants of the Cypress Swamp.

TREES

Magnolia virginiana
Sweetbay
Pinus elliottii
Slash pine
Quercus laurifolia
Laurel oak
Taxodium ascendens
Pond-cypress

SHRUBS

Baccharis glomeruliflora
Groundsel-tree
Cephalanthus occidentalis
Buttonbush
Hypericum myrtifolium
Hypericum virginicum
St. John's-wort
Ilex cassine
Dahoon
Myrica cerifera
Wax-myrtle

GRASSES, SEDGES, RUSHES

Amphicarpum purshii
Amphicarpum
Andropogon spp.
Broomsedge
Cyperus spp.
Sedges
Eleocharis baldwinii
Spikerush
Fuirena scirpoides
Umbrella grass
Juncus spp.
Rushes
Panicum hemitomon
Maidencane

EPIPHYTES

Tillandsia recurvata
Ball moss
Tillandsia usneoides
Spanish moss

FERNS, LIVERWORTS

Phlebodium aureum
Serpent fern
Ricciocarpus natans
Liverwort
Thelypteris dentata
Marsh fern

OTHER MONOCOTS

Nymphaea odorata
Water lily
Pontederia lanceolata
Pickerel weed
Sagittaria isoetiformis
Duck potato

OTHER DICOTS

Aster dumosus
Aster
Centella asiatica
False coinwort
Eupatorium capillifolium
Dog-fennel
Hydrocotyle umbellata
Coinwort
Ludwigia linifolia
Ludwigia pilosa
Evening primrose
Lycopus rubellus
Water hoarhound
Polygonum persicaria
Knotweed
Pluchea rosea
Marsh fleabane
Rhexia mariana
Meadow beauty
Utricularia purpurea
Utricularia sp.
Bladderwort

return of normal water levels (Duever et al., 1976). These ponds may again become occupied by cypress, either after peat has accumulated from aquatic plants or during a period of subnormal precipitation and concomitant low water levels. Cypress seedlings and young saplings require moist soil but cannot tolerate total submersion for more than a few days at a time (Demaree, 1932). Once established, cypress trees tolerate indefinite flooding (Wagner and Kurz, 1954). Trees of other species are unable to tolerate summer flooding with the exception of swamp tupelo (*Nyssa biflora*). The highly acid waters which are very low in available nutrients further preclude the establishment of other species. The reasons for the predominance of cypress over tupelo have not been elucidated. Clewell (1971) noted that the water levels in cypress ponds tend to fluctuate more frequently or more widely than in ponds dominated by swamp tupelo.

Seral Trends - Logging has had the effect of creating microhabitats in the form of stumps upon which the trees of several hydric hardwoods have become established. These hardwoods also would invade if the regional water table were lowered or if peat or sediments accumulated. If the regional water table were raised, the cypress would persist indefinitely, even centuries, but plants of all other species would die, except submersed aquatic herbs.

Fauna - Pig frogs were heard calling in many parts of the swamp. Cotton mice were seen, and a nest was discovered that probably belonged to a rice rat. EcoImpact, Inc., (1974) reported bobcat signs. Other animals typically inhabiting cypress swamps in central Florida are the mosquitofish, least killifish, golden topminnow, pygmy sunfish, green tree grog, common newt, water snakes, fox squirrel, and several birds that nest there, including the osprey, common egret, cattle egret, wood stork, white ibis, black-crowned night heron, great blue heron, and anhinga (Harrison, 1975; Reilly, 1968). Several amphibians breed in cypress swamps. Nesting and breeding activities were not observed in the cypress swamp, owing to the season of observation.

Animals of the cypress swamp community of potential use to man are the pig frog, bobcat, fox squirrel, and the wading birds.

Functions - Cypress swamps serve as catch-basins during wet seasons for runoff from surrounding uplands. In dry seasons water seeps laterally, keeping the soils of adjacent pine flatwoods moist for extended periods. Birds and amphibians which spend much of their time in other habitats use cypress swamps for nesting. Animals of other habitats may use the swamps for protection from predators and as a source of water during droughts.

4. WATER COMMUNITIES

The Swift Duette mine property contains three stream segments: East Fork Manatee River, North Fork Manatee River, and Little Manatee River. The overall objective of the aquatic ecological research program was to accumulate baseline data on the indigenous communities in the above systems (Figure 4-1 shows locations of the stations). The stations were located on distinct habitats: a riffle, a pool and a disturbed channel in each drainage. Seasonal variation was addressed by sampling twice during the year (during extremes of temperature - summer and winter, 1978).

Baseline data collected in the aquatic environs of the Duette mine property culminated from the following four major studies:

- A quantitative study of *stream metabolism* (Production/Respiration values evaluated by diel dissolved oxygen method)
- A quantitative evaluation of *phycoperiphyton communities* (Attached micro-algae; artificial substrate method)
- A quantitative elucidation of *benthic macroinvertebrate communities* (Natural and artificial substrate methods)
- A qualitative evaluation of *fish communities* (by electroshocking method)

The streams of the Duette mine site are generally devoid of benthic macrophytes. Dense shade cast by the overhanging swamp forests excludes the light required for the growth of aquatic plants. A few areas that lack a dense canopy, though, support growths of *Nuphar lutea* (spatter dock), *Ludwigia palustris* (evening primrose), *Panicum purpurascens* (para

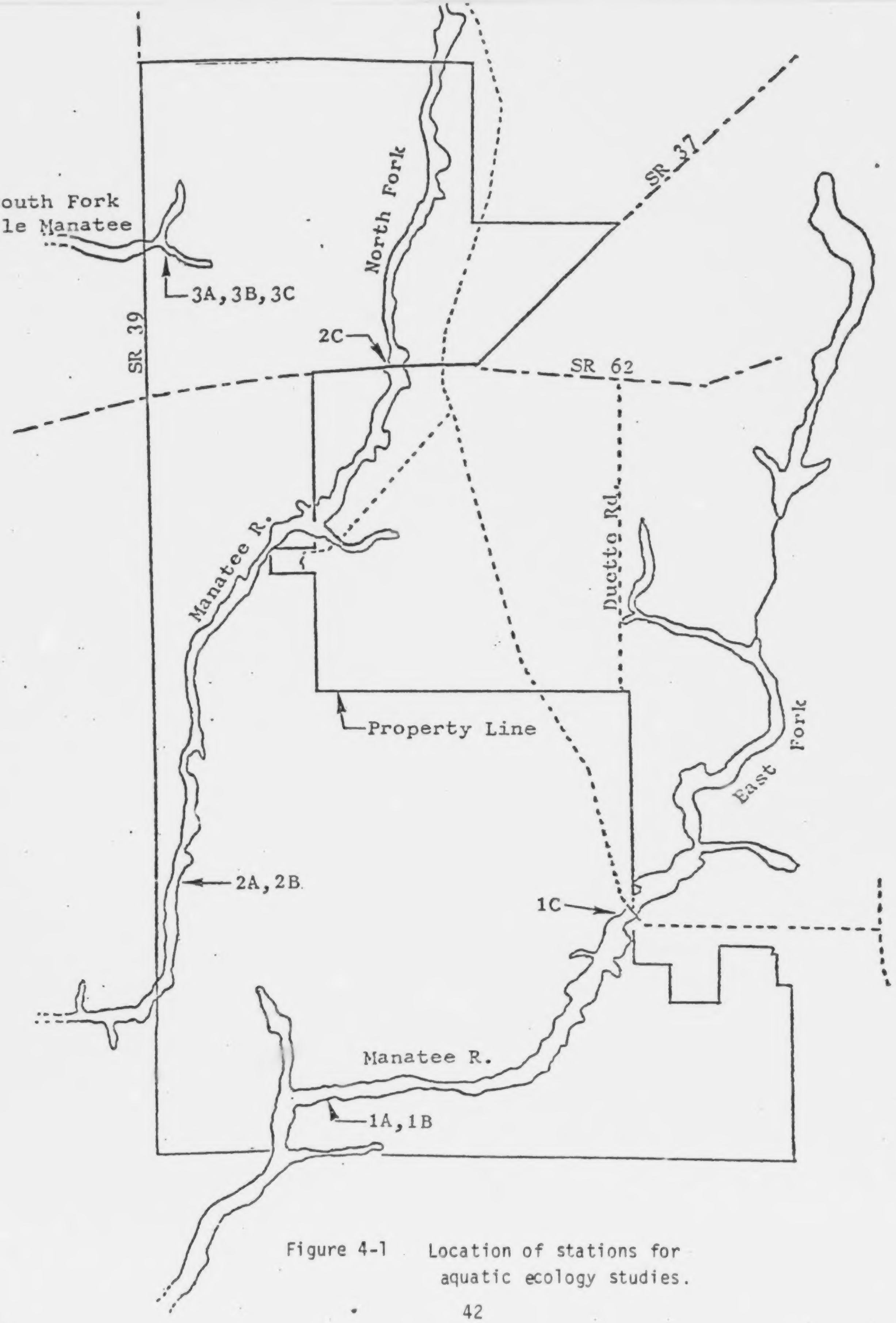

South Fork
.ttle Manatee
3A,3B,3C
North Fork
SR 37
2C
SR 39
SR 62
Manatee R.
Ductto Rd.
Property Line
East Fork
2A,2B
1C
Manatee R.
1A,1B

Figure 4-1 Location of stations for aquatic ecology studies.

grass), and Potamogeton diversifolius (pondweed). Interruptions in the canopy are often the result of disturbance by man.

4.1 Stream Metabolism

Studies of community metabolism are useful for evaluating environmental quality since community metabolism is a measurement which integrates all aspects of the biota, including some components which are not readily assessed directly (i.e. decomposers). The method has been used in a variety of waters (Odum, 1956, 1957a, 1957b; Odum & Hoskin, 1858; Kelly, Fitzpatrick & Pearson, 1978). The elements of this study included measurements of solar radiation, diurnal dissolved oxygen, and diurnal temperature. These measurements allowed estimations of community respiration and gross production.

Methods - Community metabolism was determined by the diurnal oxygen curve method of Odum and Hoskin (1958). Dissolved oxygen and temperature were measured at five stations (Figure 4-1) with YSI model 57 oxygen meter. Samples for dissolved oxygen by the Winkler titration method were taken at each station as a back-up. The dissolved oxygen and temperature measurements were made over a 24 hour period at four-hour intervals beginning at 0700 on 31 August, 1978.

Solar radiation was measured with a Belfort Instrument Co. recording pyroheliometer placed in an open field near Station 1C.

Limitations - With only a single calculation of community metabolism, no estimate could be made of temporal variations. That temporal variation can be significant was shown by Kelly et.al. (1973) who recorded approximately a tenfold annual variation in gross production and a fivefold annual variation in community respiration. Spatial variation is adequately addressed by the study. The method employed assumes a lack of spatial variation (Odum and Hoskin, 1958; Owens, 1969). This was found to be a reasonable assumption except as noted below in the Discussion section.

Accurate determination of community metabolism requires knowledge of the rate of oxygen diffusion. Odum and Hoskin (1958) assume the coefficient of diffusion is constant over the diurnal period and is estimated from observed rates of oxygen change at night under different levels of saturation. Talling (1969) has pointed out that the coefficient of diffusion can vary considerably with varying surface conditions (i.e. wind). Since meteorological conditions were stable during the study period, the Odum and Hoskin method is assumed to be adequate.

The Odum and Hoskin method also assumes that respiration is constant throughout the 24-hour period. Owens (1969) has suggested the need to correct the respiration rate for varying temperatures and dissolved oxygen concentrations. Since temperature and dissolved oxygen fluctuations were small, the assumption that the respiration rate was constant was considered adequate.

Results - The total solar radiation for the Swift site on 31 August 1978 was 403.25 g-cal/cm^2. Light was available from approximately 0715 to 1930 (Figure 4.1-1). No unusual variations in light intensity occurred. Cloudiness depressed the rate of solar radiation from 1615 to 1715.

Water temperatures ranged from 24.4°C (Station 2AB at 0830) to 28.2°C (Station 1C at 1515 and 1900)(Table 4.1-A).

The lowest dissolved oxygen values were recorded at stations 2C (0.05 - 0.10 ppm) and 3ABC (2.10 - 2.63 ppm)(Table 4.1-B). The remaining stations had dissolved oxygen concentrations between 3.70 and 5.15 ppm.

Dissolved oxygen values ranged between 0.89 and 93.58 percent of saturation (Table 4.1-C). The lowest values were at stations 2C (0.89 - 1.77 percent of saturation) and 3ABC (36.52 - 47.75 percent of saturation). The other stations had values ranging between 64.91 and 93.58 percent of saturation.

Figure 4.1-2 illustrates the method for calculating community respiration and gross production for station 1AB. Table 4.1-D lists the values for community respiration and gross production for each of the stations. In every case, respiration exceeded production. Community respiration ranged between 0.38 and 2.30 gO_2/m^2/day. Gross primary production ranged from 0.088 to 0.153 gO_2/m^2/day. The data from Station 2C were not used since no fluctuations occurred in dissolved oxygen.

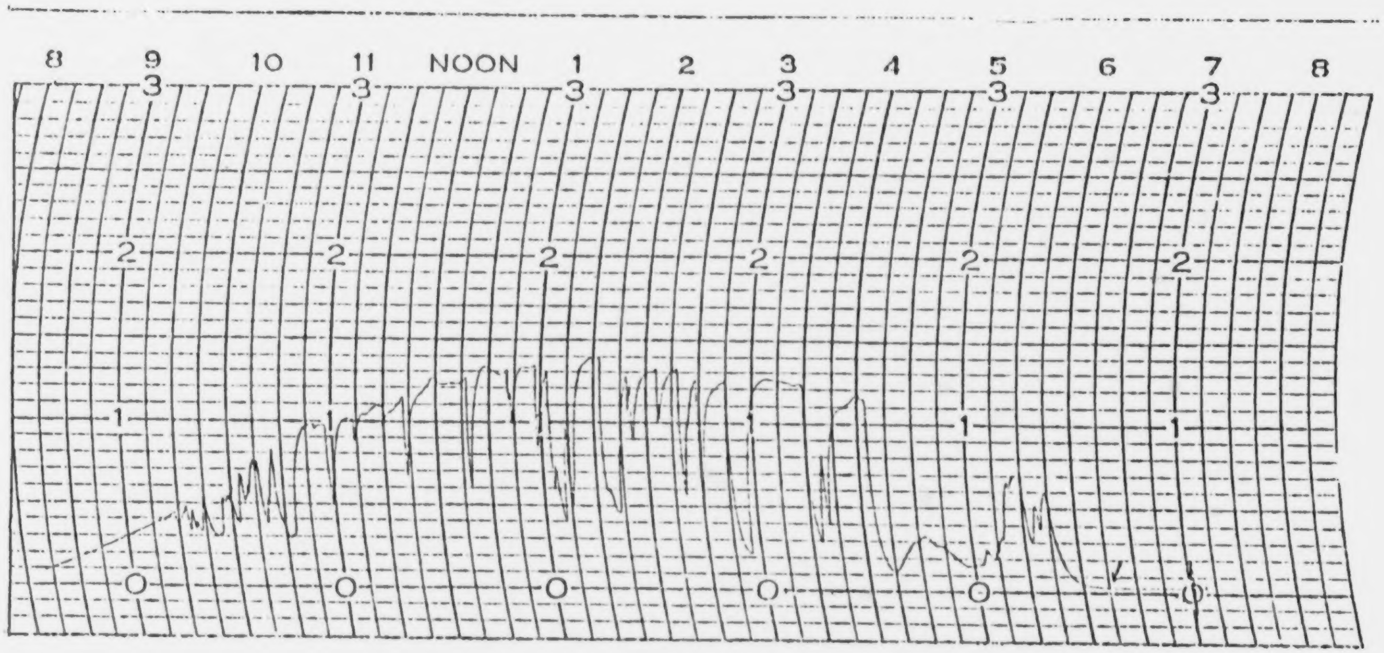


Figure 4.1-1 Pyroheliometer recording for 31 August 1978 at Duette Mine site.

Table 4.1-A Diurnal Temperature Measurements at Selected Sites on Manatee and Little Manatee Rivers.

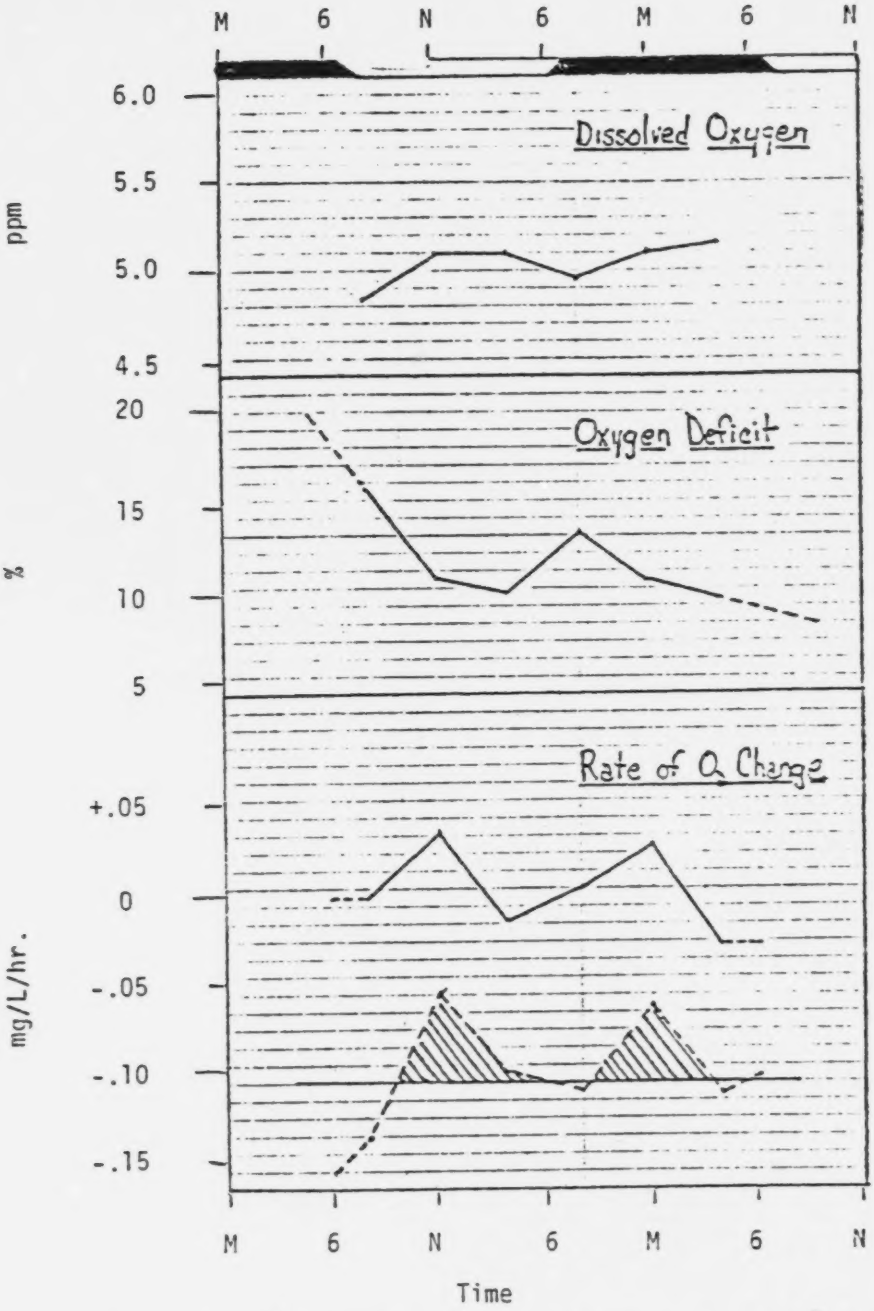
Station	Temperature (°C) at Four Hour Intervals					
	(Sunrise) 1	2	3	(Sunset) 4	5	6
1AB	25.5	26.0	26.7	26.2	26.1	26.1
1C	26.6	27.0	28.2	28.2	28.0	27.3
2AB	24.4	26.0	26.8	26.2	25.1	24.7
2C	26.0	26.8	27.0	26.6	26.2	25.8
3ABC	25.7	27.4	26.5	27.0	26.0	25.8

Table 4.1-B Diurnal Dissolved Oxygen Measurements at Selected Sites on Manatee and Little Manatee Rivers.

Station	DO Values (ppm) at Four Hour Intervals					
	(Sunrise) 1	2	3	(Sunset) 4	5	6
1AB	4.85	5.10	5.10	4.95	5.10	5.15
1C	4.95	4.85	5.10	5.00	4.95	5.10
2AB	4.00	3.70	4.23	4.10	4.20	4.45
2C	0.10	0.10	0.05	0.10	0.10	0.10
3ABC	2.63	2.65	2.58	2.40	2.20	2.10

Table 4.1-C Percentage Saturation of Dissolved Oxygen at Selected Sites on Manatee and Little Manatee Rivers.

Station	Percentage Saturation of DO at Four Hour Intervals					
	(Sunrise) 1	2	3	(Sunset) 4	5	6
1AB	84.35	89.47	90.27	86.84	89.47	90.35
1C	87.61	86.61	93.58	91.74	90.00	91.89
2AB	67.23	64.91	74.87	71.93	73.68	76.07
2C	1.75	1.77	0.89	1.77	1.75	1.74
3ABC	45.74	47.75	45.66	42.86	38.60	36.52



$R = (0.11\ gO_2/m^3/hr)(24\ hr/day)(0.25\ m) = 0.66\ gO_2/m^2/day$

$GPP = (37\ squares)(0.01\ gO_2/m^3/square)(0.25\ m) = 0.092\ gO_2/m^2/day$

Figure 4.1-2 Dissolved Oxygen, oxygen deficit, and rate of change curves for Station 1AB.

Table 4.1-D Community Respiration and Gross Primary Production at the Duette Mine Site, 31 August 1978.

Station	Community Respiration $gO_2/m^2/day$	Gross Primary Production $gO_2/m^2/day$
1AB	0.660	0.0925
1C	0.384	0.092
2AB	0.522	0.088
3AB	2.304	0.153

Discussion - The streams on the site are shallow and densely shaded. As a result, little submerged or emergent vegetation is present. The lack of vegetation is reflected in the low gross primary productivity calculated by this study. Gross production at this site ranged from 0.088 to 0.153 $gO_2/m^2/day$ compared to values reported by Odum (1957b) of 0.7 - 64 $gO_2/m^2/day$ and 1.1 - 23.8 $gO_2/m^2/day$ by Odum and Hoskin (1958). Community respiration was also low: 0.38 - 2.3 $gO_2/m^2/day$ in this study compared to 1.61 - 17.6 $gO_2/m^2/day$ reported by Odum and Hoskin (1958).

In each case, respiration exceeded production indicating the system relies on an outside source of energy. This conclusion is corroborated by the oxygen saturation data. The dissolved oxygen level was always less than saturation indicating more organic matter is being consumed than produced (Odum and Hoskin, 1958).

Two of the stations studied are not typical for the area. Station 2C is a borrow area for the construction of a bridge. During much of the year a dense mat of water hyacinth (Eichhornia crassipes) covers the surface. Dissolved oxygen readings were very low throughout the day. This area cannot meet the requirements of this method of stream homogeniety (Odum, 1957a; Odum and Hoskin, 1958), therefore respiration and production were not calculated.

Station 1C has been channelized, resulting in an absence of the forest canopy. Because sunlight reaches the water, dense beds of vegetation are present in the stream. However, the diurnal oxygen curve was very similar to the undisturbed stations (1AB, 2AB) so the requirement of stream homogeniety was assumed to be met. Respiration and production were similar to stations 1AB and 2AB.

Conclusions -

a) The streams on the Duette Mine site have low values for community respiration and gross primary production.

b) Community respiration exceeds gross production indicating a need for an extraneous source of energy.

4.2 Periphyton

Periphyton communities are considered good indicators of water quality conditions (Patrick, 1957; Cairns et al., 1968; Weber, 1973a; Kingsbury and Rees, 1978) mainly due to their role as primary producers in stream systems. Changes in species composition, density, diversity and biomass of periphyton communities are often indicative of pollutional stress (Williams, 1972; Archibald, 1972; Cairns et al., 1972; Weber, 1973b; Patrick, 1973; Olive and Price, 1978). Baseline information collected for the periphyton communities at the Duette mine site consisted of the following elements:

- Species composition
- Density
- Biomass
- Chlorophyll 'a'
- Autotrophic index
- Species Richness
- Species Diversity
- Equitability
- Oligomixity (single species dominance)
- Community similarity between seasons (temporal) and sites (spatial)

This section summarizes the results of the periphyton study that was conducted during the winter and summer of 1978. Appendix I presents the data in a more detailed format. Appendix II lists the taxonomic references used in identifications of organisms.

The term periphyton refers only to the algal component of attached microbiota or the phycoperiphyton, sensu Foerster and Schlichting (1965).

Methods - Samples were collected by means of suspended slides incubated in the field for two weeks. Processing and enumeration methods were identical to those described by Weber (1973a). Twelve replicate slides were collected at each station. Four slides each were utilized for the analysis of species abundance, biomass and chlorophyll 'a' (phaeophytin corrected).

Data analysis consisted of computing an autotrophic index (Weber, 1973b), species diversity as the Gini's or Simpson's index (Gini, 1912: Simpson, 1949) and the Shannon-Weaver index (Shannon and Weaver, 1963), equitability as the Pielou's index (Pielou, 1966) and community similarity by means of the Morisita's overlap index (Morisita, 1959). Oligomixity of the periphyton community was estimated as the percentage of a single species dominance at the station/site. Species richness was measured as the total number of species per station or per site. The multi-approach in data analysis was employed to describe spatial and temporal variations in all major community structure parameters.

Limitations - Temporal data were collected for a winter and a summer sampling period. Seasonality in periphyton populations are usually extensive and are also dependent on stream flow conditions. The data collected for the winter and summer sampling periods are, however, indicative of optimum community structure during two extremes of temperature conditions and therefore could be regarded as a reasonably adequate data-base for the purpose of predicting environmental effects.

Results -

Species composition: A total of 53 taxa were identified from the samples collected during the two seasons. Fourteen species accounted for about 90% of the total periphyton abundance at the three sites. (Table 4.2-A). Overall, the four most dominant species (comprising 51.86% of the total periphyton abundance) were Synedra pulchella, Oscillataria species A., a filamentous green species, and a coccoid green species B. Saptially, S. pulchella was more abundant at Site 3 (Little Manatee River), Oscillatoria species A was more abundant at Site 1 (East Fork Manatee River) and the filamentous green species the most dominant species at Site 2 (North Fork Manatee River). Temporally, S. pulchella was abundant at all three sites both in the winter and summer. Oscillatoria species A., coccoid green species A., and the filamentous green species were generally abundant only in the summer.

Density: Density (number of cells per mm^2) values at each station are summarized in Table 4.2-B. In general, density was higher in the summer when compared to winter. Significant exceptions were Stations 2C, 3A, and 3B where winter density values were higher than summer values. A summary of density patterns at each site is presented in Table 4.2-C. In general, both in winter and summer, density values at Site 2 were lower than those of Sites 1 and 3. In the winter, Site 3 had a greater density than Site 1, while in the summer both sites had comparable values of density. Based on yearly averages, density was highest at Site 3, with lower densities at Site 1 and Site 2. A comparison of density levels at the different habitats (Pool, Riffle and Channel) showed that while pool and riffle densities were similar, densities in the channel stations were higher (Figure 4.2-1). A significant exception to this trend occurred at Site 1 during

Table 4.2-A Abundance (# cells/mm^2) and Percentage Composition of Dominant Periphyton Taxa (> 1%) (temporal averages).

Species	Site 1 Stations 1A, 1B & 1C #/mm^2	 %	Site 2 Stations 2A, 2B & 2C #/mm^2	 %	Site 3 Stations 3A, 3B & 3C #/mm^2	 %	All Sites Sites 1, 2 & 3 #/mm^2	 %
CHLOROPHYTA								
Coccoid Green sp. A.	45	27.42	1	2.14	2	0.89	13	12.31
Coccoid Green sp. B.	10	5.95	1	2.56	1	0.45	4	3.00
Filamentous Green sp.	2	1.41	9	23.50	5	2.69	6	4.25
Spondylosium sp.	0	0.00	1	2.56	4	2.15	2	1.29
CHRYSOPHYTA								
Achnanthes sp. A.	2	1.41	2	5.13	27	14.26	10	7.94
Achnanthes sp. B.	7	3.93	7	17.95	18	9.78	10	8.06
Achnanthes sp. C.	0	0.00	0	0.00	20	10.49	7	5.02
Eunotia pectinalis	5	2.72	3	6.41	3	1.44	3	2.49
Navicula sp. A.	4	2.32	0*	0.42	18	9.87	7	5.75
Ophephora marytii	0	0.00	0	0.00	6	2.96	2	1.42
Pennate sp. C.	0	0.00	0	0.00	11	5.83	4	2.79
Synedra pulchella	27	16.13	6	15.38	44	23.77	26	19.73
Synedra ulna	0*	0.20	1	1.71	4	2.06	2	1.24
CYANOPHYTA								
Oscillatoria sp. A.	51	30.95	7	17.95	3	1.52	20	15.57
TOTAL (Dominant Species)	153	92.44	38	95.71	166	88.16	116	90.86
TOTAL (All Species)	165	100.00	39	100.00	186	100.00	130	100.00

*Average less than 0.5.

Table 4.2-B Summary of Periphyton Community Characteristics during Winter (W) and Summer (S), 1978.

Parameter	Sta. 1A		Sta. 1B		Sta. 1C		Sta. 2A		Sta. 2B		Sta. 2C		Sta. 3A		Sta. 3B		Sta. 3C	
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
1. Density (# Cells/mm^2)	37	450	40	192	92	181	22	17	15	21	125	34	97	34	101	18	225	640
2. Species Richness (# Species/station)	5	17	8	22	10	21	5	8	4	6	10	6	11	11	6	9	14	32
3. Biomass Dry weight (grams/m^2)	1.2	3.5	0.7	2.0	1.2	3.5	1.0	1.8	1.3	4.0	1.6	0.8	1.9	1.3	1.7	1.5	2.0	1.0
Ash-free dry weight (grams/m^2)	0.5	1.0	0.3	1.0	0.8	1.3	0.3	0.5	0.3	1.3	0.6	0.3	1.0	0.5	0.7	0.5	0.8	0.5
4. Chlorophyll 'a' (phaeophytin corrected)	0.049	0	0.690	0	0.394	0.095	0.014	0	0.426	0	0.188	0	0.089	2.267	1.016	0	0.658	0
5. Autotrophic Index (Biomass/Chlorophyll 'a')	1.02×10^7	∞	4.30×10^5	∞	2.03×10^6	1.37×10^7	2.14×10^7	∞	7.00×10^5	∞	3.19×10^6	∞	1.12×10^7	2.21×10^5	6.90×10^5	∞	1.22×10^6	
6. Percentage Oligomixity (% dominance by single species)	81.08	61.11	40.00	55.73	35.87	23.20	54.55	47.06	40.82	66.67	43.20	67.65	46.39	38.24	72.28	33.33	34.22	18.28
7. Species Diversity a) Shannon-Weaver Index, 'H'	0.70	1.15	1.65	1.57	1.91	2.23	1.23	1.58	1.21	1.02	2.09	1.05	1.65	1.91	0.91	1.96	1.78	2.53
b) Gini's Index	0.33	0.59	0.87	0.65	0.81	0.86	0.66	0.76	0.71	0.54	0.78	0.52	0.72	0.81	0.45	0.87	0.78	0.89
8 Equatibility, J' (Pielou's Index)	0.44	0.41	0.80	0.52	0.83	0.73	0.77	0.76	0.87	0.63	0.91	0.59	0.69	0.80	0.51	0.89	0.67	0.73

Table 4.2-C Summary of Community Characteristics of the Periphyton (spatial totals of threes stations at each site) during Winter (W) and Summer (S), 1978.

Parameter	Site 1 Manatee R. E. Fork		Site 2 Manatee R. N. Fork		Site 3 Little Manatee R.		Average for Study Area	
	W	S	W	S	W	S	W	S
1. Density (# cells/mm^2)	57	274	50	24	141	232	83	177
2. Biomass a. Dry Weight (Grams/m^2)	1.0	3.0	1.3	2.2	1.9	1.3	1.4	2.2
b. Ash-free dry weight (grams/m^2)	0.5	1.1	0.4	0.7	0.8	0.7	0.6	0.8
3. Species Richness (# taxa/site)	16	29	12	12	23	35	17	25
4. Species Diversity a. Shannon's Index (H'-nats)	1.96	1.81	1.99	1.55	1.94	2.57	1.96	1.98
b. Gini's Index (D)	0.75	0.74	0.81	0.72	0.76	0.89	0.77	0.78
5. Equitability (Pielou's J')	0.71	0.54	0.80	0.63	0.62	0.72	0.71	0.63
6. Percentage Oligomixity (Dominance by single taxa)	45.93	37.18	35.76	38.36	42.65	16.79	41.45	30.78
7. Community Similarity between Seasons (Cλ between W and S)	0.28		0.27		0.48		0.34	

winter, where density levels of the riffle and pool stations were higher than the channel.

Biomass:: Biomass (dry weight and ash-free dry weight grams/m^2) values at each station are summarized in Table 4.2-B. In general, station-specific trends exhibited by biomass were similar to those shown by density. Based on yearly averages, biomass was similar at all three sites (contrary to density pattern). Summer biomass values were generally higher than winter values (Table 4.2-C). Contrary to density patterns, riffle, pool and channel biomass did not show marked differences (Figure 4.2-2).

Chlorophyll 'a': Chlorophyll 'a' concentrations were extremely low at all stations (Table 4.2-B). In most cases, summer samples contained a lower concentration of chlorophyll 'a' when compared to winter samples (exception Station 3A). The generally low values of chlorophyll 'a' are indicators of low photosynthetic production in the system. This trend is substantiated by results from the stream metabolism study.

Autotrophic Index: The autotrophic index (ash-free dry weight/chlorophyll 'a' concentration) is purported to indicate water quality conditions (Weber, 1973). Higher values (over 100) of this index are indicative of organic pollution (Weber and McFarland, 1969), since the bulk of biomass is contributed by large populations of filamentous bacteria, stalked protozoa and other non-photosynthetic organisms. Autotrophic index values at all the stations were high (Table 4.2-B) and were indicative of heterotrophic conditions of the system.

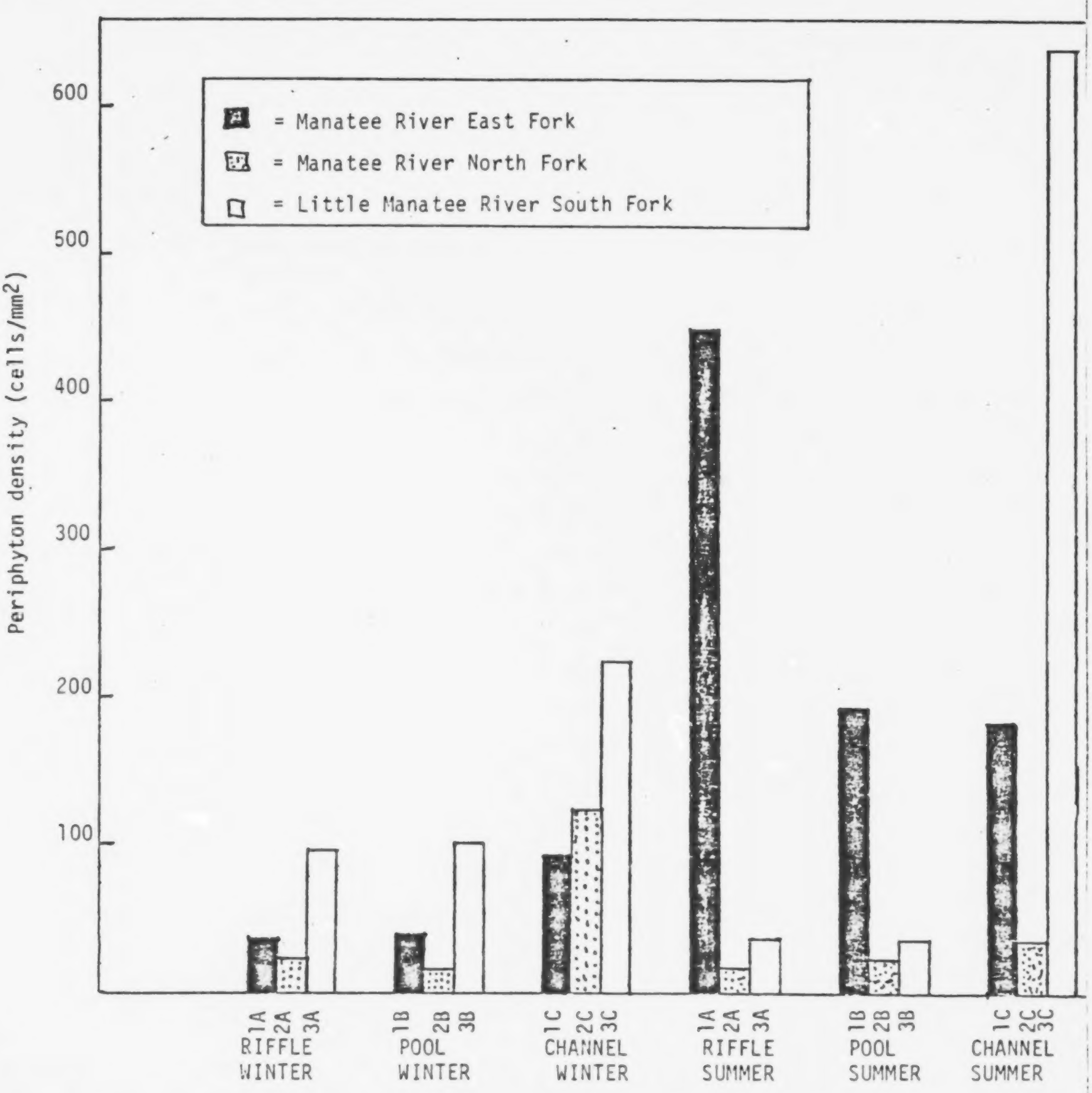


Figure 4.2-1 Periphyton density patterns at different habitats during winter & summer, 1978.

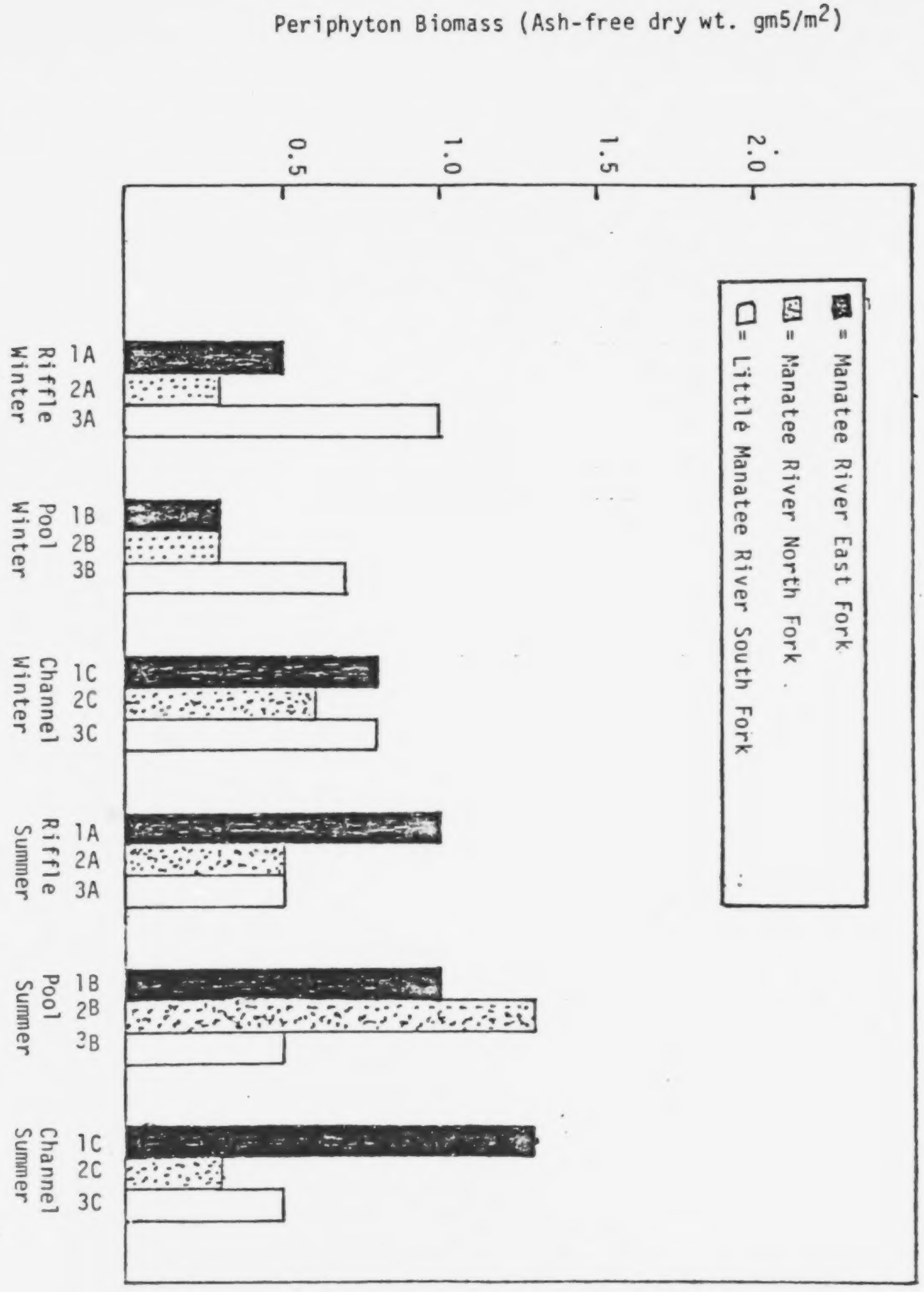


Figure 4.2-2 Periphyton biomass patterns at different habitats during winter and summer, 1978.

Species richness : Species richness values (number of species/station) at each station are presented in Table 4.2-B. Except for stations 2C and 3A, an increase in species richness during summer was evident at all stations. Considering total species richness at each site (Table 4.2-C), higher values in the summer were obtained for Sites 1 and 3, while Site 2 remained unchanged. Overall, Site 2 contained the lowest species richness, while Site 3 exhibited the highest species richness. Comparing different habitats, the riffle and pool stations contained similar species richness (exceptions: Sites 1 and 2 in the winter) (Figure 4.2-3).

Species diversity - Species diversity was estimated as both the Shannon's index (Shannon and Weaver, 1963) and Gini's index (Gini, 1912; Simpson, 1949) and values for each station presented in Table P. Diversity values were generally higher in the summer when compared to winter samples. However, comparing average species diversity for the whole study area, diversity values were similar between summer and winter (Table 4.2-C). Spatial differences in diversity values were usually minimal (Table 4.2-B). Comparing diversity values in different habitats, the riffle stations, in general, exhibited lower diversity values than pool and channel stations (Figure 4.2-4).

Equitability : Equitability or evenness values (Pielou's index, J') for each station is presented in Table 4.2-B. Equitability values at Site 3 (Little Manatee River) were higher in the summer when compared to winter samples. At other sites (Manatee River), equitability values were similar or lower during the summer sampling period. The apparent anamolous temporal trend in equitability between the two systems (Little Manatee vs. Manatee) is not corroborated by species diversity and richness patterns. Overall equitability values at the

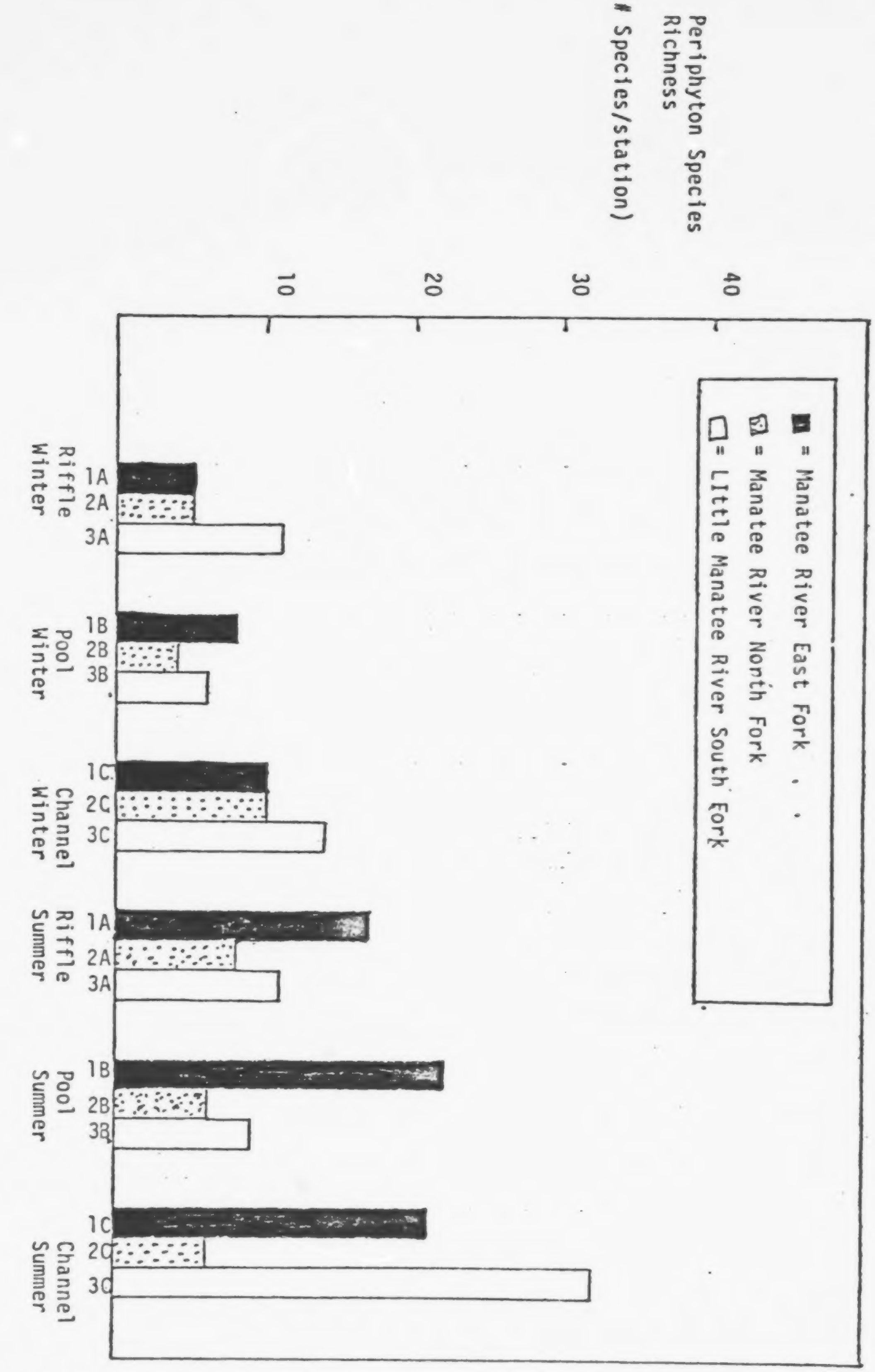


Figure 4.2-3 Periphyton species richness patterns at different habitats during winter and summer, 1978.

three study sites (Table 4.2-C) substantiated the temporal trend exhibited by individual stations. Spatially, equitability values (averages) were generally similar at the three study sites (corroborating the diversity pattern).

Oligomixity : Oligomixity is defined as the percentage dominance (in numbers of organisms) by a single species. Theoretically, a higher oligomixity indicates a lower diversity and therefore presumably an assemblage that is under "stress" (caused by "natural phenomena" in the case of this study) (Thienemann, 1954). Oligomictic communities are also characterized by high densities, low species richness, low species diversity and low equitability. Percentage oligomixity values for each station are presented in Table4.2-B. Overall values for each site are presented in Table4.2-C. Except for Site 2, winter samples were more oligomictic than summer samples. Spatially, Site 3 (Little Manatee River) was slightly lower in oligomixity than the other two sites.

Biocoenoces similarity: Similarity of the communities between the sites was estimated by utilizing the Morisita's index (Morisita, 1959). The index values range from 0 to 1, with values closer to 1 indicating high similarity. The index is more powerful than conventional species overlap coefficients (e.g., method employed by Patrick et al., 1967) since it takes into consideration both the number of species that are common and the individuals shared by them.

Temporal similarity of communities at the Manatee River sites (Sites 1 and 2) was low (Table 4.2-C). However, similarity of community between winter and summer sampling periods at the Little Manatee River (Site 3) was moderately high. A matrix depicting community

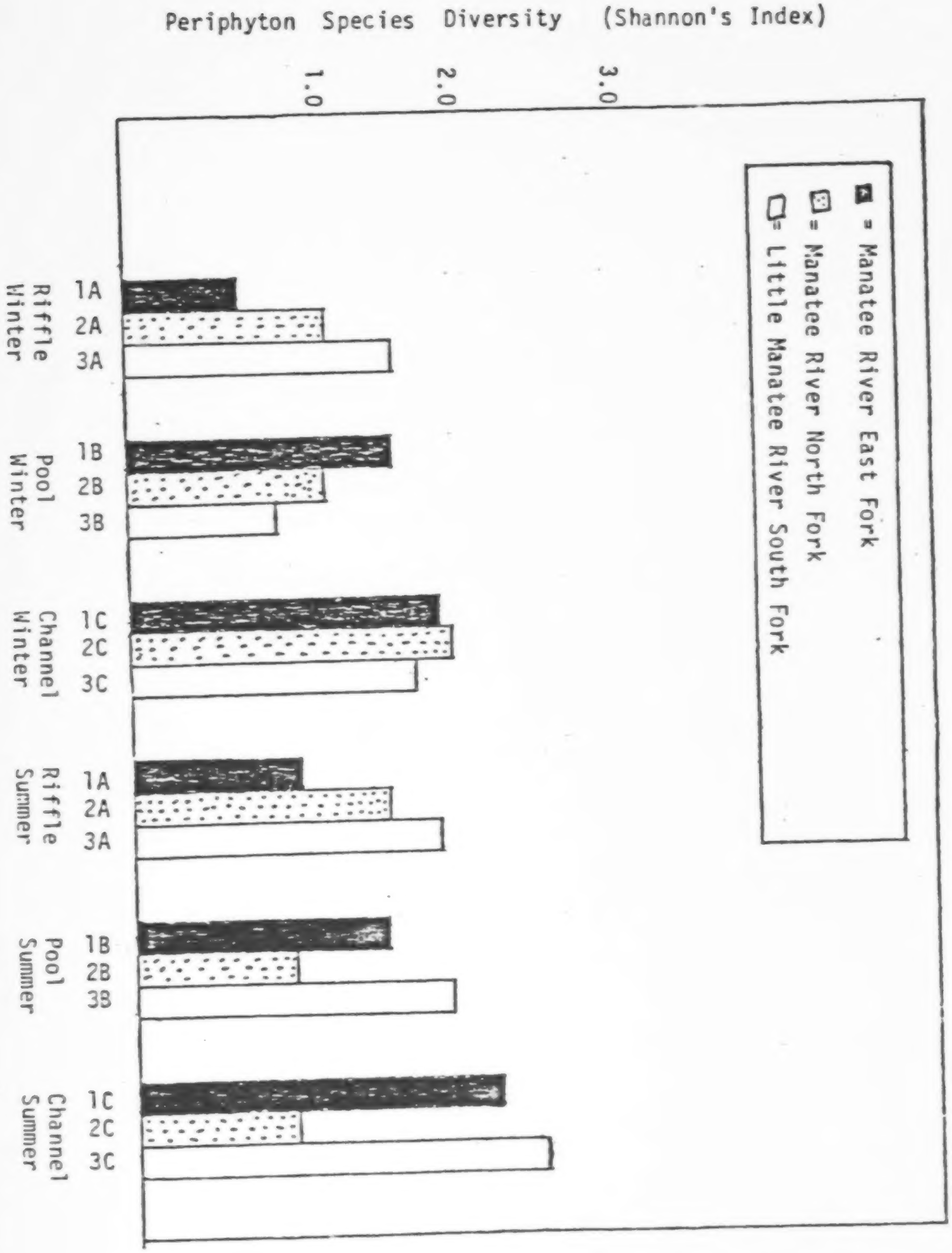


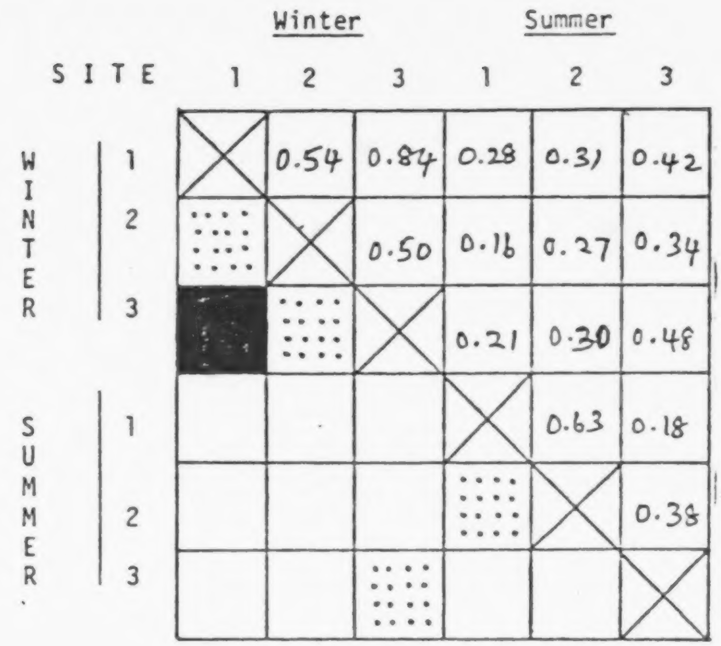
Figure 4.2-4 Periphyton species diversity patterns at different habitats during winter and summer, 1978.

similarity between the three sites during winter and summer sampling periods is shown in Figure 9. Spatial homogeneity of periphyton communities is evident for the winter sampling period (i.e., all three sites contained similar species composition and assemblage). During the summer, Manatee River sites were similar to each other (i.e., North Fork vs. East Fork) but were both dissimilar to the Little Manatee River site. The similarity of winter and summer communities at the Little Manatee River site appears to create the spatial heterogeneity.

Discussion : Various community structural parameters were estimated to provide baseline information on the "natural" state of the micro-algal communities at the stream systems of the Duette mine site. Because community structure parameters are site and season specific, the baseline generated from this study is only valid for the sites studied and the two seasons sampled.

Evaluation of the community structure and species composition at the aquatic environs of the Duette mine site (see Results) showed that the indigenous periphyton communities could be classified as follows:

- Dominance by few species
- Low levels of density and biomass (relative to values reported from elsewhere, e.g., Weber and Raschke, 1970)
- Moderate species richness
- Moderate diversity
- Moderate equitability
- Moderate oligomixity



		Winter			Summer		
	SITE	1	2	3	1	2	3
WINTER	1	☒	0.54	0.84	0.28	0.31	0.42
	2	⁙	☒	0.50	0.16	0.27	0.34
	3	■	⁙	☒	0.21	0.30	0.48
SUMMER	1				☒	0.63	0.18
	2				⁙	☒	0.38
	3			⁙			☒

■ = High Similarity ($c\lambda \geq 0.7$)

⁙ = Moderate Similarity ($c\lambda \geq 0.5 < 0.7$)

☐ = Low Similarity ($c\lambda < 0.5$)

Figure 4.2-5 Trellis diagram depicting similarity of Periphyton communities between three study sites (Site 1: Manatee River East Fork; Site 2: Manatee River North Fork; Site 3: Little Manatee River) during winter and summer, 1978, utilizing pooled data from three stations at each site.

Spatial and temporal differences were more pronounced in density, biomass, and species richness. In evaluating community similarity, temporal dissimilarity was more pronounced than spatial differences. Overall, the Manatee River (East and North Forks) could be considered as an identifiably (in periphyton communities) separate system from that of Little Manatee River. Based on periphyton chlorophyll 'a' values and the autotrophic index, the aquatic environs at the Duette mine site could be classified as a detrital-based system (extremely heterotrophic) similar to many heterotrophic stream ecosystems in other geographical areas (e.g., Perkins and Kaplan, 1978).

Conclusions -

a) Community characteristics such as density, biomass, and species richness indicated detectable natural spatial and temporal variation.

b) Dominance was pronounced since four species accounted for over 50% of the total abundance at the three study sites.

c) Species diversity exhibited very little spatial and temporal variation

d) In species similarity, the Manatee River sites exhibited a greater similarity to each other than with the Little Manatee River site. Lack of marked temporal change in the community at the Little Manatee River site (in contrast to the Manatee River sites) was ecologically significant in delineating the site.

e) The aquatic environs at the Duette mine site appear to be a detrital based system (heterotrophic). Characteristics of the periphyton community (e.g. dominance, density, species richness, etc.) appear to reflect the natural state of such a system.

4.3 Benthos

Benthic macroinvertebrates are considered excellent indicators of present and past water quality because of their constant presence, relative longevity, sedentary habits and differing tolerance of stress (Gaufin and Tarzwell, 1952; McKee, 1966; Mackenthun, 1966; Cairns and Dickson, 1971; Dills and Rogers, 1972; Goodnight 1973; Anger, 1977). Changes in species composition and community structure of benthic assemblages are often indicative of pollution stress (Menzies et al., 1952; Hartman, 1959, McNulty, 1961; Wilheim, 1967; Reish, 1972, Cairns et al., 1972; Swartz, 1972; Crossman et al., 1974; Simmons and Voshell, 1978; Swartz, 1978). To evaluate benthic community characteristics (baseline) at the Duette Mine site, the following elements were considered:

- Species composition
- Indicator species composition
- Faunal density
- Biomass
- Species richness
- Species diversity
- Equitability
- Faunal similarity

Substrate characteristics in the study area were also evaluated to explain faunal variations at the study site. This section summarizes the results of the benthic study conducted during the winter and summer of 1978. Appendix I presents the data in a more detailed format. Appendix II lists the taxonomic references used in identifications of organisms.

Methods - Samples of the natural substrate were collected by a petite ponar grab (sampling area: 0.022 m^2) (Powers and Robertson, 1967). To augment the natural substrate samples, artificial substrate samples (Hester and Dendy, 1962 - sampling area: 0.15 m^2) incubated for four weeks in the field were also collected. Four natural substrate samples and three artificial substrate samples were collected at each of the nine sampling stations during winter and summer, 1978. Samples were washed through a 0.5 mm sieve, stained with a rose bengal solution (to facilitate ease and accuracy in sorting), fixed in 10% formalin and preserved in 70% isopropyl alcohol. Organisms were sorted, enumerated and identified to the lowest practical taxonomic level. Chironomids were slide-mounted for identification purposes. The non-chironomid fauna of the natural substrate samples were used to estimate biomass (wet, dry and ash-free dry weights) at each station.

To provide an overall and comprehensive picture of the benthic communities at the study area, data analysis was conducted in three approaches:

a) Natural substrate fauna (Ponar grab).

b) Artificial substrate fauna (Hester-Dendy samples).

c) Overall fauna (combined information from Ponar grab and and Hester-Dendy samples).

Estimation of the various community parameters were indentical to the methods utilized for periphyton samples (see Section 4.2).

Rigorous data analysis was also conducted on the chironomid component because of their exceptional utility in water quality assessment studies (Beck, 1977) and better taxonomic separation.

Limitations - Data were collected for two seasons (winter & summer periods). Seasonal variations in benthic fauna are frequent (although not as extensive as periphyton communities) and are often related to stream flow conditions (e.g. Williams and Hynes, 1976). The data collected in the study are, however, indicative of optimum community structure during two extremes of temperature conditions and therefore could be regarded as a reasonably adequate data base for the purpose of predicting environmental effects.

Results -

Substrate Characteristics: Sediment characteristics at the study areas are presented in Table 4.3-A. Calculations of the grain size statistical parameters were conducted according to formulae presented by Folk (1968). Percentage silt/clay was estimated by the material passing through a 0.062 mm sieve. Percentage organic content was obtained by combusting at 500°C, and percentage carbonate by combusting at 1000°C.

Generally, sediment grain size characteristics were similar both spatially and temporally, indicating a course heterogeneous type substrate. Leaf litter was observed at a majority of the stations. Unusually high silt/clay content (with accompanying high organic content) was observed at Stations 2C, 3A, and 3B. Overall, site, organic and carbonate content in the sediment were low.

Table 4.3-A Sediment Analysis Summary for Winter (W) and Summer (S) Sampling; 1978.

Station	Sampling Period	Grain Size Parameters (Ø Units)							
		M Median	M_z Mean	σ Sorting	Sk Skewness	Kg Kurtosis	% Silt-Clay	% Organic	% Carbonate
1A	W	1.85	1.92	0.62	0.16	0.77	0.02	0.10	0.019
	S	1.57	1.57	0.45	0.20	1.13	0.14	0.09	0.008
1B	W	1.86	1.95	0.75	0.24	0.90	2.14	2.75	0.145
	S	1.73	1.83	0.73	0.12	1.03	0.62	3.59	0.069
1C	W	1.71	1.85	0.97	0.17	1.35	1.71	1.27	0.098
	S	1.92	1.98	0.75	0.19	0.88	0.59	1.91	0.064
2A	W	2.07	2.06	0.91	0.01	1.11	2.88	0.99	0.137
	S	1.56	1.64	0.74	0.08	1.37	0.23	1.07	0.054
2B	W	2.21	2.13	0.72	-0.10	0.90	0.81	1.17	0.038
	S	2.12	2.08	0.66	-0.07	0.76	0.46	0.42	0.027
2C	W	1.88	1.95	0.71	0.17	0.81	1.27	1.65	0.637
	S	1.20	1.05	2.25	-0.02	0.62	10.66	16.44	14.125
3A	W	2.52	2.78	1.34	0.24	0.62	28.34	7.96	0.665
	S	1.94	2.02	0.87	0.17	0.98	1.68	4.65	0.258
3B	W	2.30	2.22	1.90	-0.13	1.05	18.54	29.00	1.003
	S	1.52	1.39	2.25	-0.05	0.71	14.79	30.71	1.759
3C	W	2.20	2.16	0.83	0.02	0.89	1.12	2.11	0.060
	S	1.02	2.05	0.89	0.06	1.06	1.78	3.25	0.165

Species Composition: Abundance (# organisms/m^2) and percentage compostion of the most dominant species ($\geq$ 5%of total fauna at each site) at the three study sites for the natural substrate fauna, artificial substrate fauna and the combined fauna are presented in Tables 4.3-B, 4.3-C and 4.3-C, respectively. Faunal composition between the natural substrate and artificial substrate samples were quite different. Except for oligochaeta and the chironomids, Rheotanytarsus exiguus and Tanytarsus sp., dominant species between the two sample types were different. While Oligocheata dominated the natural substrate samples, the two chironomids were more abundant in the artificial substrate samples. Overall (Table 4.3-D), 15 species accounted for over 80% of the benthic macroinvertebrates collected during the study. In all, 121 species were identified from a total of 34,261 organisms sorted and enumerated from the study. A majority of the dominant species at the study sites were either omnivores or scavengers.

Based on the three most abundant taxa at the study site (Oligochaeta, R. exiguus and Tanytarsus sp.) spatial and temporal differences were evident. Spatially, highest densities were observed at Site 3 (Little Manatee River) followed by lower densities at Site 1 (Manatee - East Fork) and Site 2 (Manatee - North Fork). Temporally, Chironomids exhibited a density reduction in the summer, while Oligochaeta showed a greater or similar density during summer (compared to winter).

Table 4.3-B Abundance (#/m^2) and Percentage Composition of Dominant Species ($\geq$ 5% of total) at the Three Study Sites based on Ponar grab Samples during Winter (W) and Summer (S), 1978.

SPECIES	SITE 1				SITE 2				SITE 3					
	W		S		W		S		W		S		TOTAL	
	#/m^2	% Comp.	#/m^2	% Comp.	#/m^2	% Comp.	#/m^2	% Comp.	#/m^2	% Comp.	#/m^2	% Comp.	#/m^2	% of Total
ANNELIDA														
Oligochaeta sp.	2378	43.00	5152	51.52	1000	23.62	1515	54.53	6159	65,16	5737	72.35	3657	54.96
Hirudinea														
Unidentified sp. A	11	0.20	11	0.11	648	15.31	7	0.27	22	0.24	41	0.51	123	1.85
MOLLUSCA														
BIVALVIA														
Pisidium-Sphaerium	130	2.34	270	2.70	230	5.42	348	12.53	219	2.31	874	11.02	345	5.18
GASTROPODA														
Ferrissia sp.	4	0.07	26	0.26	59	1.40	0	0	581	6.15	4	0.05	112	1.69
INSECTA														
COLEOPTERA														
Dubiraphia sp.	226	4.09	978	9.78	19	0.44	19	0.67	0	0	0	0	207	3.11
CERATOPOGONIDAE														
Unidentified sp.	296	5.36	137	1.37	59	1.40	44	1.60	96	1.02	285	3.60	153	2,30
CHIRONOMIDAE														
Polypedilum halteralis	530	9.58	333	3.33	185	4.37	11	0.40	26	0.27	0	0	181	2,72
Polypedilum scalaenum	107	1.94	644	6.44	541	12.77	337	12.13	78	0.82	285	3.60	332	4.99
Unknown Chironomini sp.	422	7.63	4	0.04	0	0	0	0	0	0	0	0	71	1.07
Rheotanytarsus exiguus	396	7.17	300	3.00	59	1.40	4	0.13	44	0.47	4	0,05	135	2.02
Tanytarsus sp.	237	4.29	181	1.81	241	5.69	7	0.27	693	7.33	7	0.09	228	3.43
SUBTOTAL	4737	85.67	8036	80.36	3041	71.82	2292	82.53	7918	83.77	7237	91.27	5544	83.32
Contribution of rare (<5%) species	792	14.33	1964	19.64	1193	28.18	485	17,47	1534	16.23	692	8.73	1110	16.68
TOTAL	5529	100.00	10,000	100.00	4234	100.00	2777	100.00	9452	100.00	7929	100.00	6654	100.00

Table 4.3-C Abundance (#/m^2) and Percentage Composition of Dominant Species ($\geq$ 5% of total) at the Three Study Sites based on Hester-Dendy Samples during Winter (W) and Summer (S), 1978.

SPECIES	SITE 1				SITE 2				SITE 3				TOTAL	
	W		S		W		S		W		S			
	#/m^2	% Comp.	#/m^2	% Comp.	#/m^2	% Comp.	#/m^2	% Comp.	#/m^2	% Comp.	#/m^2	% Comp.	#/m^2	% of Total
ANNELIDA														
Oligochaeta sp.	22	0.68	29	2.85	203	8.26	113	7.13	682	8.83	441	30.67	248	8.56
INSECTA														
EPHEMEROPTERA														
Baetis spiethi	122	3.84	16	1.61	159	6.45	259	16.26	130	1.68	0	0	114	3.93
Stenonema sp.	550	17.38	393	38.71	68	2.77	50	3.17	59	0.76	0	0	187	6.45
TRICHOPTERA														
Cheumatopsyche sp.	358	11.30	26	2.56	286	11.63	247	15.52	21	0.27	1	0.05	157	5.42
COLEOPTERA														
Stenelmis sp.	16	0.49	159	15.63	4	0.18	59	3.73	0	0	52	3.61	48	1.66
SIMULIDAE														
Simulium sp.	102	3.20	38	3.73	115	4.67	116	7.26	1	0.01	0	0	62	2.14
Unidentified Diptera pupae	153	4.84	14	1.39	84	3.44	27	1.72	256	3.22	23	1.60	93	3.21
CHIRONOMIDAE														
Dicrotendipes modestus	0	0	0	0	22	0.87	68	4.29	23	0.30	105	7.32	36	1.24
Polypedilum convictum	218	6.88	53	5.26	76	3.07	138	8.67	273	3.53	70	4.90	138	4.76
Polypedilum illinoense	0	0	0	0	87	3.53	22	1.35	484	6.27	68	4.74	110	3.79
Rheotanytarsus exiguus	522	16.49	122	12.05	173	7.05	67	4.24	1904	24.64	4	0.26	465	16.04
Tanytarsus sp.	59	1.85	30	2.99	109	4.43	118	7.41	3259	42.16	281	19.59	643	22.18
Rheocricotopus robacki	207	6.55	10	0.95	119	4.82	13	0.84	9	0.12	0	0	60	2.07
Thienemanniella xena	646	20.40	4	0.44	745	30.32	30	1.91	10	0.13	2	0.10	240	8.28
SUBTOTAL	2975	93.90	894	88.17	2250	91.49	1327	83.50	7111	92.02	1047	72.84	2601	89.73
Contribution of rare (<5%) species	193	6.10	120	11.83	209	8.51	262	16.50	617	7.98	390	27.16	298	10.27
TOTAL	3168	100.00	1014	100.00	2459	100.00	1589	100.00	7728	100.00	1437	100.00	2899	100.00

Table 4.3-D Abundance (#/m^2) and Percentage Composition of Dominant Species ($\geq 5\%$ of total) at the Three Study Sites based on totals from combined Hester-Dendy and Ponar Grab Samples during Winter (W) and Summer (S), 1978.

SPECIES	SITE 1				SITE 2				SITE 3					
	W		S		W		S		W		S		TOTAL	
	#/m^2	% Comp.	#/m^2	% Comp.	#/m^2	% Comp.	#/m^2	% Comp.	#/m^2	% Comp.	#/m^2	% Comp.	#/m^2	% of Total
ANNELIDA														
Oligochaeta sp.	414	11.63	883	35.14	336	12.19	347	19.41	1595	19.90	1323	52.55	816	23.15
MOLLUSCA														
BIVALVIA														
Pisidium-Sphaerium	22	0.61	45	1.79	38	1.39	58	3.25	36	0.45	148	5.88	58	1.64
EPHEMEROPTERA														
Baetis spiethi	106	2.96	17	0.69	138	5.02	217	12.12	113	1.41	0	0	99	2.79
Stenonema sp.	461	12.95	331	13.17	60	2.17	43	2.42	51	0.64	0	0	158	4.47
TRICHOPTERA														
Cheumatopsyche sp.	303	8.50	29	1.16	238	8.65	206	11.50	20	0.25	1	0.02	133	3.77
COLEOPTERA														
Dubiraphia sp.	38	1.06	163	6.49	3	0.11	3	0.17	0	0	0	0	35	0.98
Stenelmis (humerosa-sinuata gp.*)*	27	0.76	147	5.85	20	0.74	49	2.76	5	0.06	43	1.72	49	1.38
SIMULIDAE														
Simulium sp.	85	2.39	44	1.77	96	3.48	96	5.39	1	0.01	0	0	54	1.52
CHIRONOMIDAE														
Polypedilum convictum	190	5.32	75	2.97	71	2.58	116	6.49	238	2.96	61	2.40	125	3.55
Polypedilum illinoense	0	0	0	0	77	2.78	19	1.04	411	5.12	62	2.45	95	2.69
Polypedilum scalaenum	19	0.52	120	4.77	91	3.32	63	3.52	14	0.17	14	1.94	54	1.53
Rheotanytarsus exiguus	501	14.08	152	6.05	154	5.60	57	3.18	1594	19.89	4	0.15	410	11.64
Tanytarsus sp.	88	2.48	56	2.21	131	4.75	99	5.56	2831	35.31	236	9.36	574	16.27
Rheocricotopus robacki	173	4.87	8	0.32	99	3.59	11	0.62	9	0.11	0	0	50	1.42
Thienemanniella xena	540	15.15	4	0.15	622	22.60	25	1.42	8	0.10	1	0.05	200	5.67
SUBTOTAL	2967	83.28	2074	82.53	2174	78.97	1409	78.85	6926	86.38	1893	76.52	2910	82.47
Contribution of rare (< 5%) species	596	16.72	439	17.47	579	21.03	378	21.15	1092	13.62	581	23.48	619	17.53
TOTAL	3563	100.00	2513	100.00	2753	100.00	1787	100.00	8018	100.00	2474	100.00	3529	100.00

Indicator Species: Based on Beck's (Beck, 1954; 1955) classification of indicator organisms, an analysis of the species composition at the study sites was conducted. A total of 20 Class I taxa (indicative of clean waters) and 7 Class II taxa (indicative of moderate organic pollution) were encountered in the study area. None of the Class II taxa were dominant ($\geq$ 5%) in the natural substrate samples. However, one Class II taxon (Cheumotopsyche sp.) was abundant (5.42%) in the Hester-Dendy samples. Biotic index values (Beck, 1955) at all the sites were higher than 10 indicating characteristically "clean" waters. Information derived from the indicator species concept and the biotic index should be viewed with caution because of their inherent qualitative nature.

Faunal Density: Faunal density (organisms/m^2) values at the three study sites for the natural substrate fauna, artificial substrate fauna and the combined fauna are presented in Tables 4.3-E, 4.3-F and 4.3-G respectively. Overall (Table 4.3-G), density was lower during the summer when compared to winter samples. Density patterns at the three study sites, are shown graphically in Figures 4.3-A, 4.3-2 and 4.3-3. Based on natural substrate samples (Figure 4-9), faunal density was comparable between Sites 1 and 3 but much less at Site 2. The artificial substrate samples, however, showed that density values were similar between Sites 1 and 2, but greater at Site 3 (Figure 4.3-2). The overall trend was similar to that portrayed by the artificial substrate samples (Figure 4.3-3). Therefore, based on density patterns, Sites 1 and 2 (Manatee River - East & North forks) would be classified as similar systems that are both different from Site 3 (Little Manatee River).

ble 4.3-E Summary of Community Characteristics of Macroinvertebrates at the Three Study Sites (spatial totals of three stations at each site) based on Ponar Grab Samples during Winter (W) and Summer (S), 1978.

Parameter	Site 1 Manatee R. E. Fork		Site 2 Manatee R. N. Fork		Site 3 Little Manatee R.		Average for Study Area	
	W	S	W	S	W	S	W	S
1. Faunal Density (# organisms / m^2)	5530	10000	4233	2778	9452	7930	6405	6903
2. Species Richness (# taxa/site)	53	48	50	40	48	34	50	41
3. Species Diversity								
a. Shannon's index (H'-nats)	2.42	2.17	2.78	1.80	1.69	1.21	2.30	1.73
b. Gini's index (D)	0.79	0.72	0.89	0.67	0.56	0.46	0.75	0.62
4. Equitability (Pielou's J')	0.61	0.56	0.71	0.49	0.44	0.34	0.59	0.46
5. Percentage Oligomixity (Dominance by single taxa)	43.00	51.52	23.62	54.53	65.16	72.35	43.93	59.40
6. Faunal Similarity between Seasons ($C\lambda$ between W and S)	0.96		0.70		0.97		0.88	

Table 4.3-F Summary of Community Characteristics of Macroinvertebrates at the Three Study Sites (spatial totals of three stations at each site) based on Hester-Dendy Samples during Winter (W) and Summer (S), 1978.

Parameter	Site 1 Manatee R. E. Fork		Site 2 Manatee R. N. Fork		Site 3 Little Manatee R.		Average for Study area	
	W	S	W	S	W	S	W	S
1. Faunal Density (# organisms / m^2)	3167	1014	2458	1590	7729	1437	4451	1347
2. Species Richness (# taxa / site)	28	43	36	49	38	48	34	47
3. Species Diversity								
a) Shannon's index (H' - nats)	2.33	2.28	2.51	2.88	1.88	2.55	2.24	2.57
b) Gini's index (d)	0.87	0.80	0.87	0.92	0.75	0.85	0.83	0.86
4. Equitability (Pielou's J')	0.70	0.61	0.70	0.74	0.52	0.66	0.64	0.67
5. Percentage Oligomixity	20.40	38.71	30.32	16.26	42.16	30.67	30.96	28.55
6. Faunal Similarity between Seasons ($C\lambda$ between W and S)	0.60		0.53		0.58		0.57	

Table 4.3-G Summary of Community Characteristics of the Macroinvertebrates at the Three Study Sites (spatial totals of three stations at each site) based on Totals Derived from Ponar Grab and Hester-Dendy Samples during Winter (W) and Summer (S), 1978.

Parameter	Site 1 Manatee R E Fork		Site 2 Manatee R N Fork		Site 3 Little Manatee R.		Average For study area	
	W	S	W	S	W	S	W	S
1. Faunal Density (# organisms/m^2)	3560	2512	2754	1788	8016	2519	4777	2273
2. Species Richness (# taxa/site)	62	68	62	69	56	59	60	65
3. Species Diversity								
a. Shannon's index (H' - nats)	2.76	2.62	2.94	2.99	2.08	2.16	2.59	2.59
b. Gini's index (D)	0.91	0.84	0.91	0.92	0.79	0.71	0.87	0.82
4. Equitability (Pielou's Index, J')	0.67	0.62	0.71	0.71	0.52	0.53	0.63	0.62
5. Percentage Oligomixity (Dominance by single taxa)	15.15	35.14	22.60	19.41	35.31	52.55	24.35	35.70
6. Faunal similarity between seasons ($C\lambda$ between W and S)	0.59		0.65		0.56		0.60	

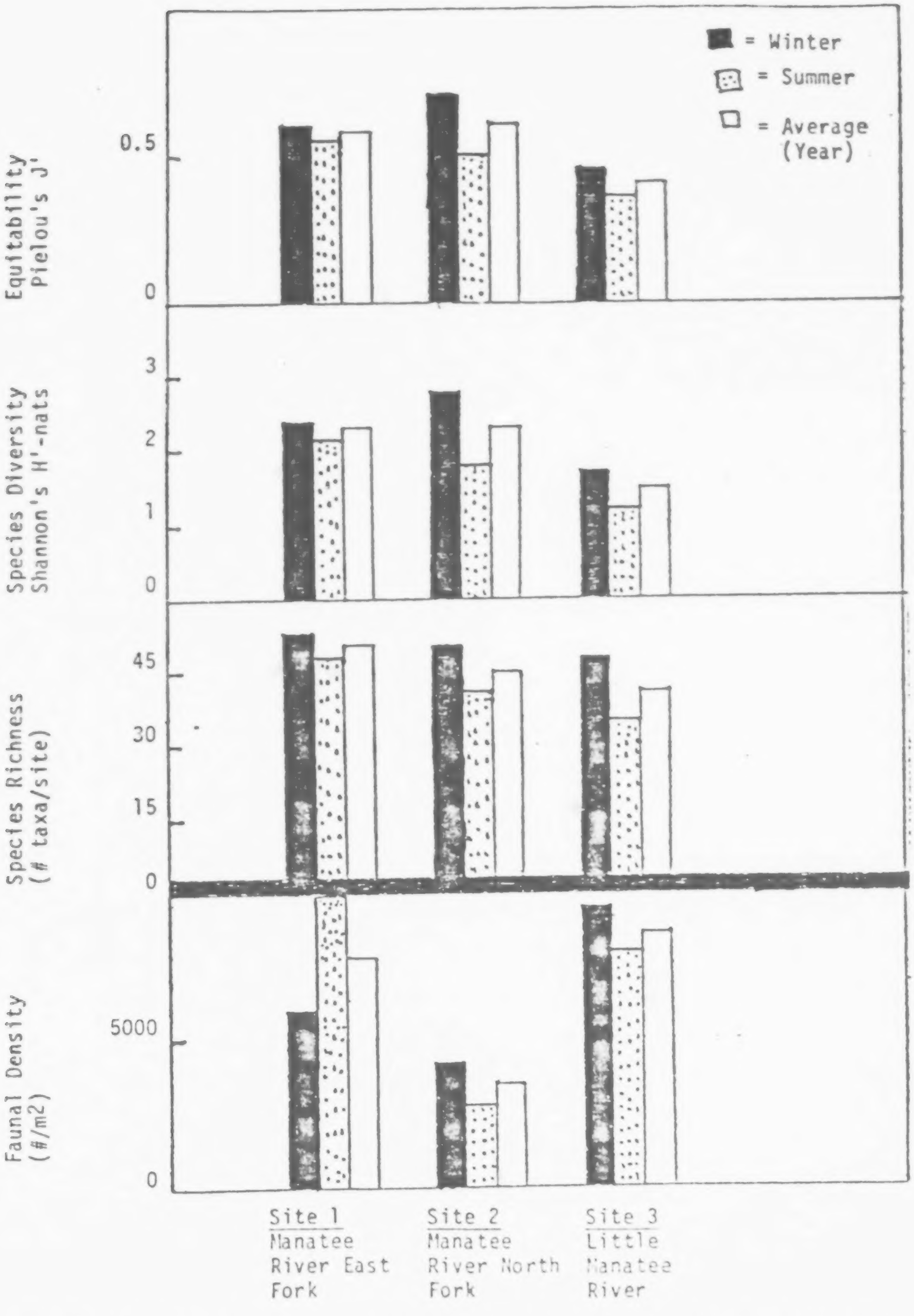


Figure 4.3-1 Benthic faunal characteristics at the three study sites during winter and summer, 1978 (based on Ponar grab samples-Natural Substrate)

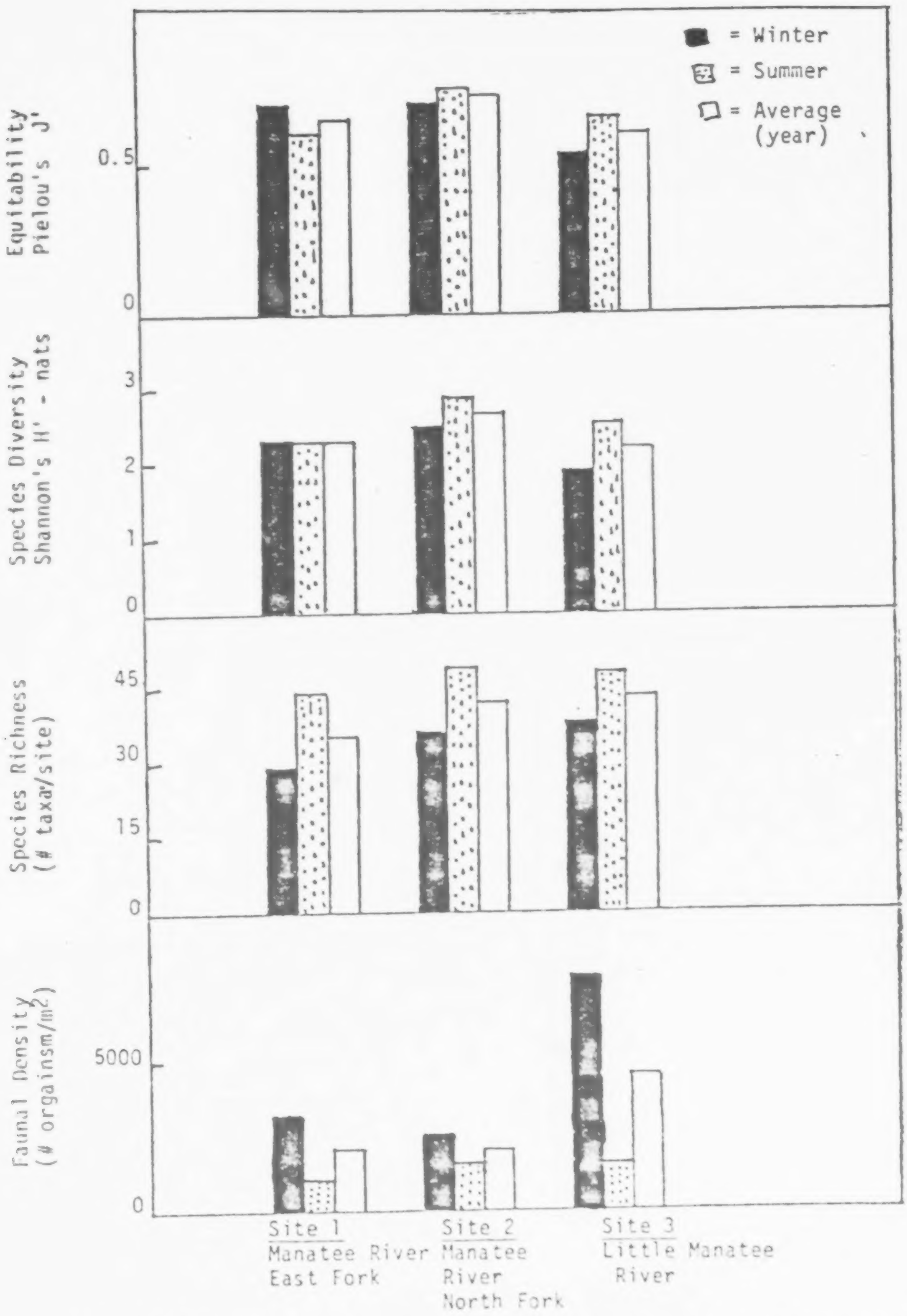


Figure 4.3-2 Benthic macroinvertebrate faunal characteristics at the three study sites during winter and summer, 1978 (based on Hester-Dendy samples - artificial substrate).

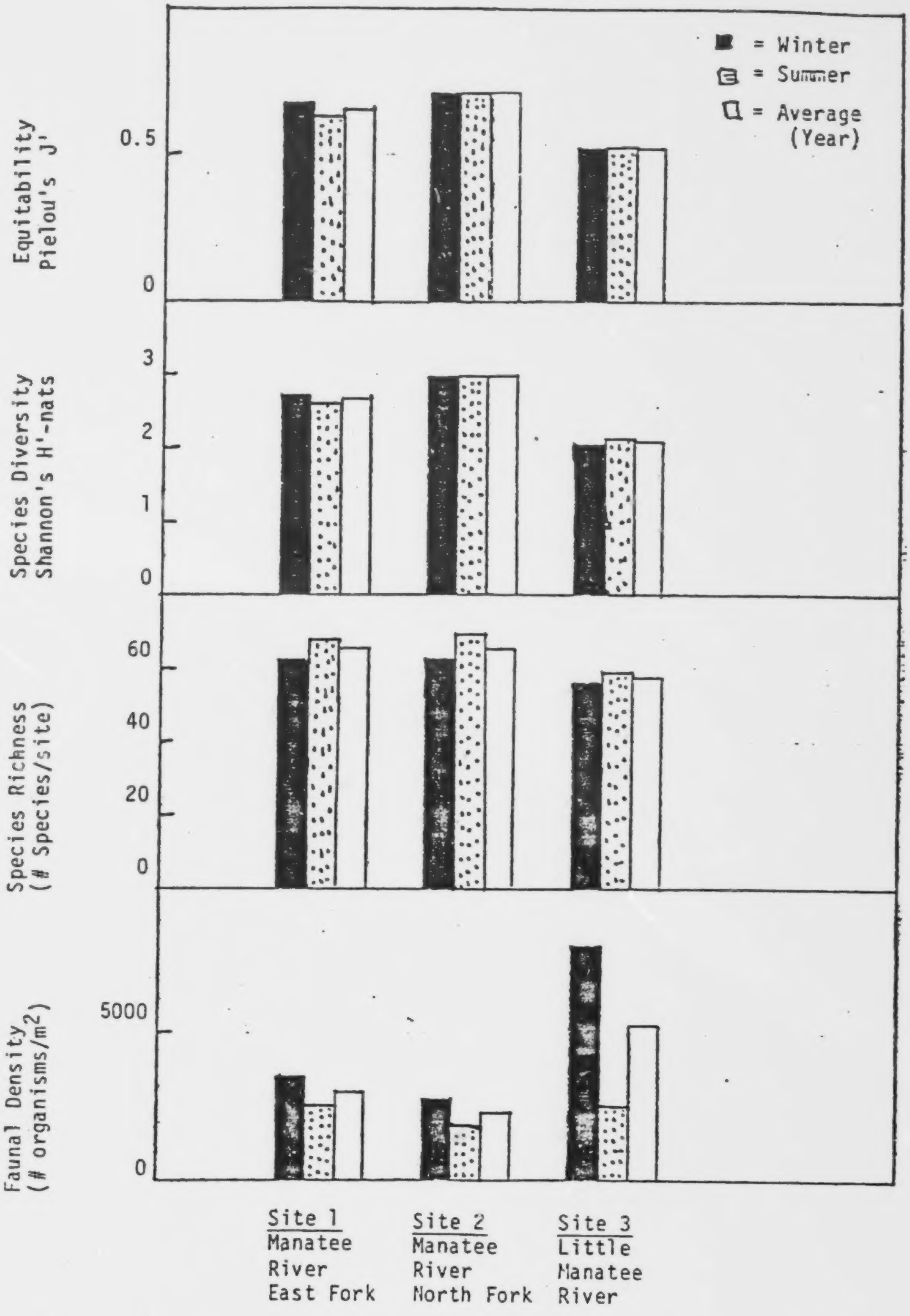


Figure 4.3-3 Benthic macroinvertebrate faunal characteristics at the three study sites during winter and summer, 1978 (based on data combined from Ponar grab and Hester-Dendy samples).

Chironomid density values at the three study sites are presented in Tables 4.3-H, 4.3-I and 4.3-J. Temporal and spatial patterns exhibited by the chironomid component were generally similar to those exhibited by the total fauna (see preceding paragraph).

Biomass: Biomass values at the three study sites (based on natural substrate samples excluding chironomids) are summarized in Table 4.3-K. In general, biomass was greater during the summer when compared to winter (in contrast to density patterns). Higher biomass values were encountered at Site 3 (Little Manatee River) with lower values at Sites 1 and 2 (Manatee River). Biomass estimates should be viewed with caution because of its partial nature (chironomids could not be included because of the necessity to slide-mount the specimens in special media for identification purposes).

Species Richness: Species richness (# taxa/site) values at the three study sites are presented in Tables 4.3-E, 4.3-F and 4.3-G. Interestingly, the natural substrate samples and artificial substrate samples showed contradicting temporal trends (see also Figures 4.3-1 and 4.3-2). While lower species richness was observed during the summer based on natural substrate samples, lower species richness was observed during the winter based on artificial substrate samples. Overall (combining both sample types), slight increases in species richness were observed during the summer (Table 4.3-G and Figure 4.3-3). Spatially, Sites 1 and 2 (Manatee River) contained similar species richness, while Site 3 (Little Manatee River) contained a lower species richness.

Table 4.3-H Summary of Community Characteristics of the Chironomid Component at the Three Study Sites (spatial totals of three stations at each site) based on Ponar Grab samples during Winter (W) and Summer (S), 1978.

Parameter	SITE 1 Manatee R. East Fork		SITE 2 Manatee R. North Fork		SITE 3 Little Manatee River		Average For Study Area	
	W	S	W	S	W	S	W	S
1. Faunal Density (# Chironomids/m^2)	1956	2189	1426	519	1363	467	1582	1058
2. Species Richness (# Chironomid taxa/ site)	17	15	19	16	20	15	19	15
3. Species Diversity								
a. Shannon's Index (H' - nats)	1.94	2.15	2.06	1.41	2.02	1.61	2.01	1.72
b. Gini's Index (D)	0.82	0.85	0.80	0.56	0.71	0.62	0.78	0.68
4. Equitability (Pielou's J')	0.69	0.79	0.70	0.51	0.67	0.59	0.69	0.63
5. Percentage Oligomixity (Dominance by single taxon)	27.08	29.44	37.92	65.00	50.82	61.11	38.61	51.85
6. Faunal Similarity between seasons ($C\lambda$ between W and S)	0.61		0.80		0.14		0.52	

Table 4.3-I Summary of Community Characteristics of the Chironomid Component at the Three Study Sites (spatial totals of three stations at each site) based on Hester-Dendy Samples during Winter (W) and Summer (S), 1978.

Parameter	SITE 1 Manatee R. East Fork		SITE 2 Manatee R. North Fork		SITE 3 Little Manatee River		Average For Study Area	
	W	S	W	S	W	S	W	S
1. Faunal Density (# Chironomids/m^2)	1772	269	1468	505	6304	673	3181	482
2. Species Richness (# Chironomid taxa/ site)	12	21	14	22	15	23	14	22
3. Species Diversity								
a. Shannon's Index (H' - nats)	1.58	2.00	1.73	2.09	1.31	2.00	1.54	2.03
b. Gini's Index (D)	0.75	0.74	0.71	0.83	0.63	0.77	0.70	0.78
4. Equitability (Pielou's J')	0.64	0.66	0.65	0.67	0.49	0.64	0.59	0.66
5. Percentage Oligomixity (Dominance by single taxon)	36.45	45.45.	50.76	27.27	51.69	41.85	46.30	38.19
6. Faunal Similarity between seasons (Cλ between W and S)	0.68		0.37		0.77		0.61	

Table 4.3-J Summary of Community Characteristics of the Chironomid Component at the Three Study Sites (Spatial totals of three stations at each site) based on Data Combined from Ponar Grab and Hester-Dendy Samples during Winter (W) and Summer (S), 1978.

Parameter	Site 1 Manatee R. E. Fork		Site 2 M anatee R. N. Fork		Site 3 Little Manatee R.		Average for Study Area	
	W	S	W	S	W	S	W	S
1. Faunal Density (# chironomids/m^2)	1802	589	1461	507	5480	638	2914	578
2. Species Richness (# chironomid taxa/site)	22	28	23	30	24	29	23	29
3. Species Diversity a. Shannon's Index (H'-nats)	1.95	2.26	2.08	2.32	1.39	2.24	1.81	2.27
b. Gini's Index (D)	0.80	0.85	0.78	0.86	0.64	0.82	0.74	0.84
4. Equitability (Pielou's J')	0.63	0.68	0.66	0.68	0.44	0.67	0.58	0.68
5. Percentage Oligomixity (Dominance by single taxon)	29.93	25.79	42.59	22.87	51.66	36.94	41.39	28.53
6. Faunal Similarity between Seasons ($C\lambda$ between W and S)	0.57		0.42		0.76		0.58	

Table 4.3-K Biomass (grams/m^2) Estimates at the Three Study Sites during Winter (W) and Summer (S), 1978.

Parameter (grams)		Site 1	Site 2	Site 3
Wet wt.	W	3.38	3.87	14.24
	S	5.71	1.96	11.14
		110.56*		
Dry wt.	W	1.60	2.28	9.76
	S	4.21	1.52	8.26
		79.70*		
Ash Free dry wt.	W	1.14	1.52	5.51
	S	3.47	0.93	7.51
		17.51*		

* Values when two (2) aberrantly large bivalves are included.

This finding is similar to that obtained from faunal density and biomass patterns.

Chironomid species richness patterns were temporally similar to those obtained for total fauna (Tables 4.3-H, 4.3-I and 4.3-J). However, spatially, all three sites contained similar levels of species richness. Therefore, based on chironomid species richness patterns, no distinction between the three sites could be made.

Species Diversity: Species diversity values (Shannon's and Gini's indices) at the three study sites are presented in Tables 4.3-E, 4.3-F and 4.3-G. In general, a reduction in species diversity occurred during the summer (based on natural substrate samples - see also Figure 4.3-1). An overall analysis (combined samples), however, showed that diversity values were remarkably similar between winter and summer samples (Figure 4.3-3). Spatially, Site 3 (Little Manatee R.) contained a lower diversity than Sites 1 and 2 (Manatee R.). Again, ite 3 appears to differ in community structure from Sites 1 and 2 (similar to the pattern shown by density, biomass and species richness).

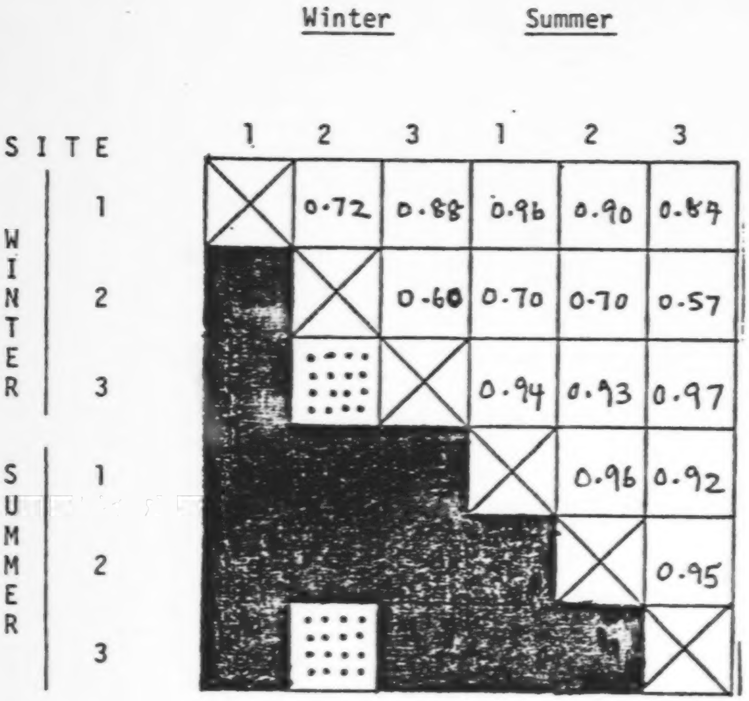
Chironomid species diversity essentially followed the temporal and spatial trends exhibited by the total fauna (Tables 4.3-H, 4.3-I & 4.3-J).

For purposes of environmental assessment, caution should be used in utilizing diversity indices because of their inherent statistical and ecological problems (Hurlbert, 1971; Peet, 1975; Godfrey, 1978).

Equitability : Equitability values (Pielou's index) at the three study sites are presented in Tables 4.3-E, 4.3-F and 4.3-G. Equitability values generally echoed the spatial and temporal trends portrayed by species diversity (see Species Diversity).

Oligomixity: Oligomixity values (percentage dominance by a single species) at the three study sites are summarized in Tables 4.3-E, 4.3-F and 4.3-G. Overall, higher oligomixity values were obtained in the summer. Site 3 (Little Manatee River) was higher in oligomixity than both Sites 1 and 2 (Manatee River). The chironimid component (Tables 4.3-H, 4.3-I and 4.3-J) exhibited similar trends in oligomixity to those portrayed by the total fauna. Consonant to patterns exhibited by other community structure parameters (preceding sections), based on oligomixity, Site 3 could be considered ecologically different from Sites 1 and 2.

Faunal Similarity - Trellis diagrams depicting faunal similarity ($C\lambda$ - Morisita's index) between the three study sites for the natural substrate samples (Figure 4.3-4), artificial substrate samples (Figure 4.3-5) and combined data (Figure 4.3-6) indicate that temporal homogeneity in communities exist at all three sites. The natural substrate samples also indicate that spatial homogeneity (primarily due to the extreme dominance of oligochaetes) exists between Sites 1 and 2 in the winter, no other spatial similarity exists. An overall analysis (Figure 4.3-6) indicated that Sites 1 and 2 are similar to each other during both seasons and dissimilar to Site 3 only in the winter. Since summer and winter communities appear to be essentially similar, Site 3 (Little Manatee River)



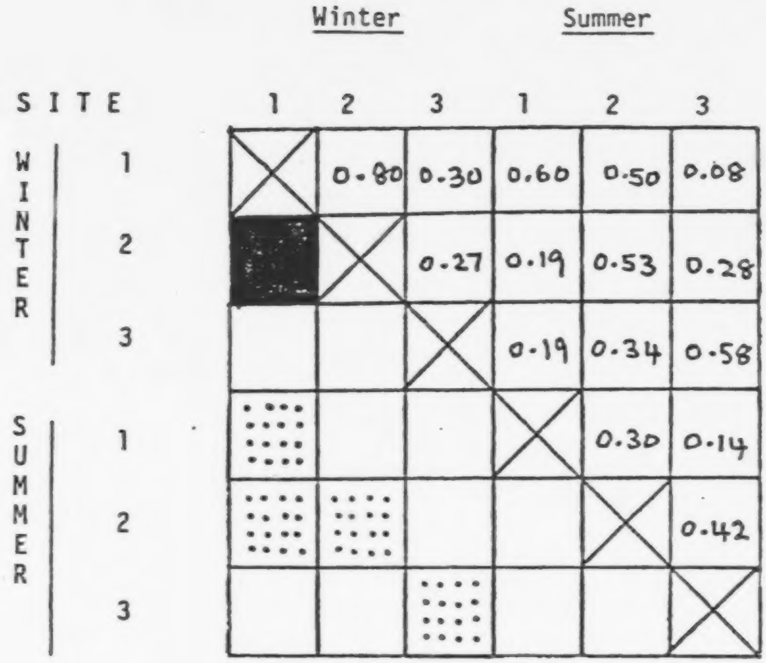
SITE		Winter			Summer		
		1	2	3	1	2	3
WINTER	1	☒	0.72	0.88	0.96	0.90	0.84
	2	■	☒	0.60	0.70	0.70	0.57
	3	■	⁙	☒	0.94	0.93	0.97
SUMMER	1	■	■	■	☒	0.96	0.92
	2	■	■	■	■	☒	0.95
	3	■	⁙	■	■	■	☒

■ = High Similarity (cλ ≥ 0.7)

⁙ = Moderate Similarity (cλ ≥ 0.5< 0.7)

☐ = Low Similarity (cλ < 0.5)

Figure 4.3-4 Trellis diagram depicting faunal similarity of macroinvertebrates between three study sites (Site 1: Manatee River East Fork; Site 2: Manatee River North Fork; Site 3: Little Manatee River) during winter and summer, 1978, utilizing pooled data of three stations at each site obtained from Ponar grab samples (natural substrate.)



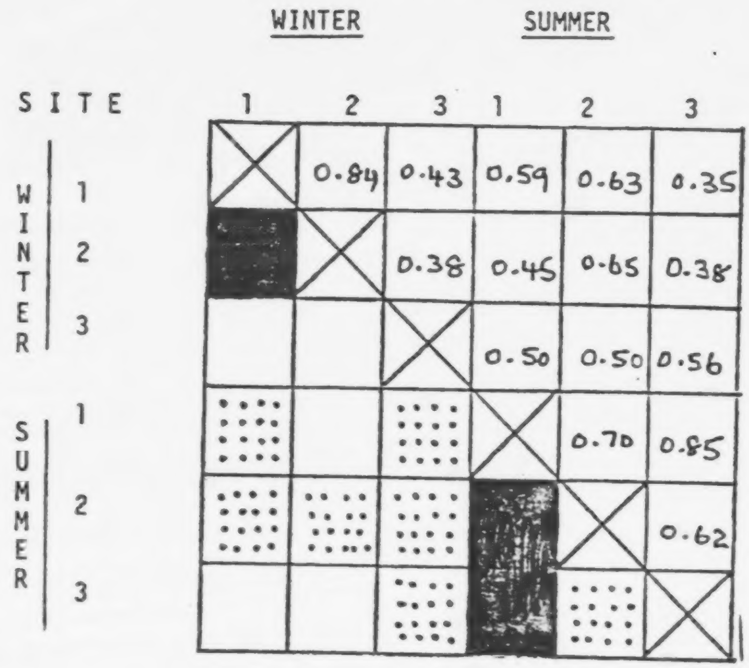
SITE		Winter 1	Winter 2	Winter 3	Summer 1	Summer 2	Summer 3
WINTER	1	☒	0.80	0.30	0.60	0.50	0.08
	2	■	☒	0.27	0.19	0.53	0.28
	3			☒	0.19	0.34	0.58
SUMMER	1	⁙			☒	0.30	0.14
	2	⁙	⁙			☒	0.42
	3			⁙			☒

■ = High Similarity (cλ ≥ 0.7)

⁙ = Moderate Similarity (cλ ≥ 0.5 < 0.7)

☐ = Low Similarity (cλ < 0.5)

Figure 4.3-5 Trellis diagram depicting faunal similarity of macroinvertebrates between three study sites (Site 1: Manatee River East Fork; Site 2: Manatee River North Fork; Site 3: Little Manatee River) during winter and summer, 1978, utilizing pooled data of three stations at each site obtained from Hester-Dendy Samples (artificial substrate).



SITE	WINTER 1	WINTER 2	WINTER 3	SUMMER 1	SUMMER 2	SUMMER 3
WINTER 1	☒	0.84	0.43	0.59	0.63	0.35
WINTER 2	■	☒	0.38	0.45	0.65	0.38
WINTER 3			☒	0.50	0.50	0.56
SUMMER 1	⁙		⁙	☒	0.70	0.85
SUMMER 2	⁙	⁙	⁙	■	☒	0.62
SUMMER 3			⁙	■	⁙	☒

■ = High Similarity ($c\lambda \geq 0.7$)

⁙ = Moderate Similarity ($c\lambda \geq 0.5 < 0.7$)

☐ = Low Similarity ($c\lambda < o.5$)

Figure 4.3-6 . Trellis diagram depicting faunal similarity of macroinvertabrates between three study sites (Site 1: Manatee River East Fork; Site 2: Manatee River North Fork; Site 3: Little Manatee River) during winter and summer, 1978, utilizing pooled data of three stations at each site combined from Ponar grab and Hester-Dendy samples.

could be inferred to contain a different community than the one indigenous to Sites 1 and 2 (Manatee River). It should, however, be noted that faunal affinities between the three sites are much stronger in the summer than in the winter. A similar analysis on the chironomid component (Figures 4.3-7, 4.3-8, 4.3-9) shows that:

a) Temporal similarity in natural substrate fauna exists only for Sites 1 and 2.

b) Temporal similarity in artificial substrate fauna exists only for Sites 1 and 3.

c) Temporal similarity in combined fauna exists only for Sites 1 and 3.

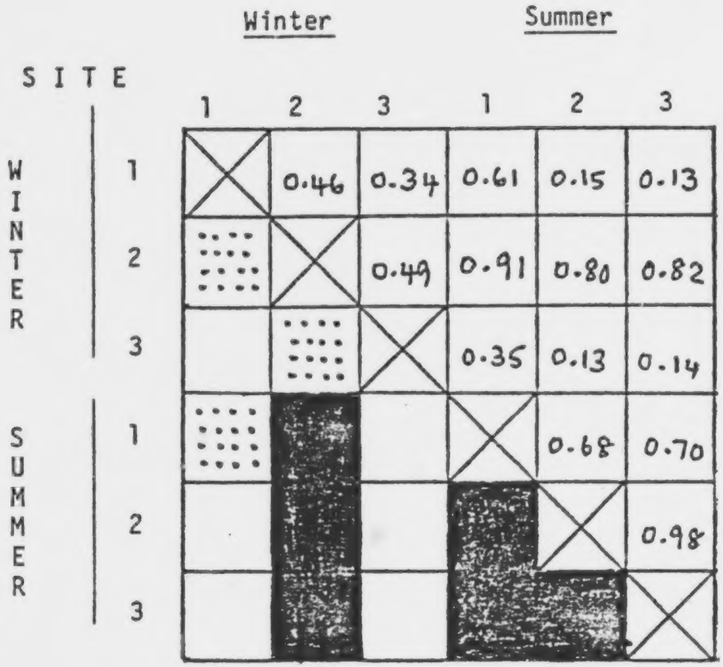
d) Spatial similarity exists for Sites 1 and 2 for all three approaches both during winter and summer.

e) Sites 1 and 2 are similar to Site 3 only in the summer and only for the natural substrate samples.

Based on the above five observations and the total fauna analysis, community similarity at the three study sites could be summarized as follows:

- The Little Manatee River essentially contains a different community than that found in the mutually similar Manatee River East and North forks.

- Summer and winter communities at both streams are essentially similar.



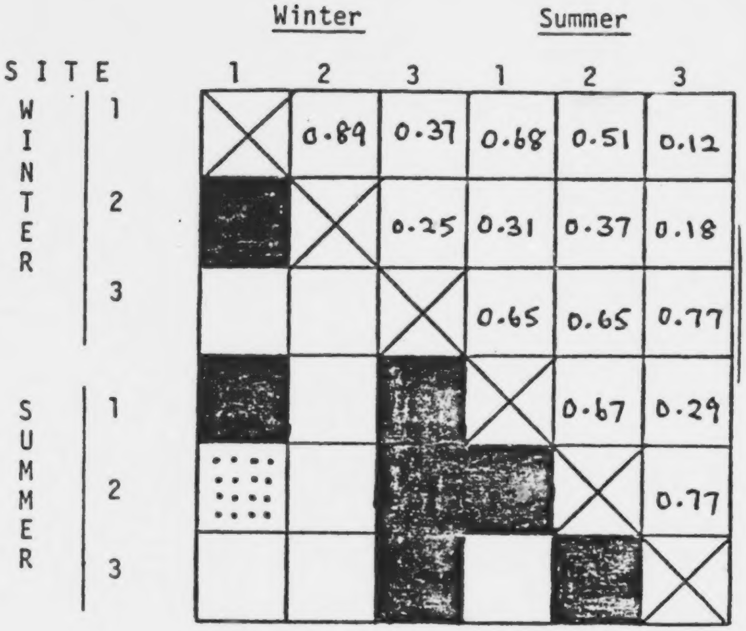
SITE		Winter 1	Winter 2	Winter 3	Summer 1	Summer 2	Summer 3
WINTER	1	╳	0.46	0.34	0.61	0.15	0.13
	2	⁘	╳	0.49	0.91	0.80	0.82
	3		⁘	╳	0.35	0.13	0.14
SUMMER	1	⁘	■		╳	0.68	0.70
	2		■		■	╳	0.98
	3		■		■	■	╳

■ = High Similarity ($c\lambda \geq 0.7$)

⁘ = Moderate Similarity ($c\lambda \geq 0.5 < 0.7$)

☐ = Low Similarity ($c\lambda < 0.5$)

Figure 4.3-7 Trellis diagram depicting faunal similarity of the Chironomid component between three study sites (Site 1: Manatee River East Fork; Site 2: Manatee River North Fork; Site 3: Little Manatee River) during winter and summer, 1978, utilizing pooled data of three stations at each site obtained from Ponar grab samples - (natural substrate).



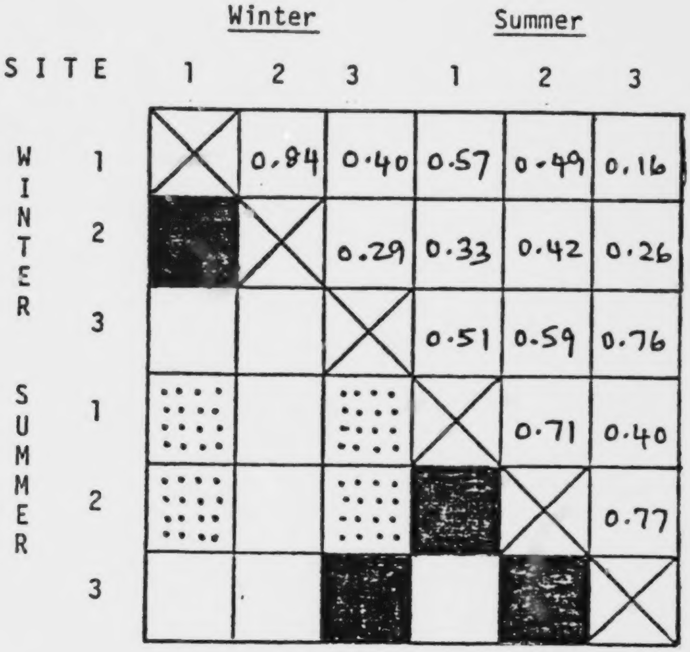
SITE		Winter 1	Winter 2	Winter 3	Summer 1	Summer 2	Summer 3
WINTER	1	☒	0.89	0.37	0.68	0.51	0.12
	2	▨	☒	0.25	0.31	0.37	0.18
	3			☒	0.65	0.65	0.77
SUMMER	1	▨		▨	☒	0.67	0.29
	2	░		▨	▨	☒	0.77
	3			▨		▨	☒

▨ = High Similarity (cλ ≥ 0.7)

░ = Moderate Similarity (cλ ≥ 0.5<0.7)

□ = Low Similarity (cλ < 0.5)

Figure 4.3-8 Trellis diagram depicting faunal similarity of the Chironomid component between three study sites (Site 1: Manatee River East Fork; Site 2: Manatee River North Fork; Site 3: Little Manatee River) during winter and summer 1978, utilizing pooled data of three stations at each site from Hester-Dendy Samples - (artificial substrate).



SITE		Winter 1	Winter 2	Winter 3	Summer 1	Summer 2	Summer 3
WINTER	1	☒	0.84	0.40	0.57	0.49	0.16
	2	■	☒	0.29	0.33	0.42	0.26
	3			☒	0.51	0.59	0.76
SUMMER	1	⁙		⁙	☒	0.71	0.40
	2	⁙		⁙	■	☒	0.77
	3			■		■	☒

■ = High Similarity ($c\lambda \geq 0.7$)

⁙ = Moderate Similarity ($c\lambda \geq 0.5 < 0.7$)

☐ = Low Similarity ($c\lambda < 0.5$)

Figure 4.3-9 Trellis diagram depicting faunal similarity of the Chironomid component between three study sites (Site 1: Manatee River East Fork; Site 2: Manatee River North Fork; Site 3: Little Manatee River) during winter and summer, 1978, utilizing pooled data of three stations at each site combined from Ponar grab and Hester-Dendy samples.

Discussion - The aquatic environment at the Duette mine property is generally devoid of benthic macrophytes, the result of dense shade by the swamp vegetation which borders the streams.

Macroinvertebrate species composition and community structure were quite different between the artificial substrate and natural substrate samples (similar to that reported by Tsui and Breedlove, 1978). However, a combination of both samples we feel provided a more comprehensive picture of the benthic communities at the study site.

The benthic macroinvertebrate communities at the study site could be characterized as follows:

- Dominance by few species
- Abundance of detrital feeders (scavengers & omnivores)
- Abundance of "clean" water species
- Moderate density and biomass
- High species richness and diversity

While temporal changes were evident in most community structure parameters, the basic community composition appears to remain relatively unchanged between summer and winter periods. Spatially, all community parameters indicate that the Little Manatee River site is essentially dissimilar to the Manatee River Site (East and North forks). Overall, the benthic communities in the aquatic environs of the Duette mine site appears to be characteristic of "clean" (sensu Beck, 1954; 1955) water conditions but a detrital based system. Although within-site variations have not been addressed in this section, substrate and seasonal temperature differences do not appear to alter substantially the bethic community structure at the study area. Perhaps stream flow conditions are more critical.

Conclusions - The following conclusions are drawn from the benthic study conducted during winter and summer, 1978, at the aquatic environs of Duette mine property:

- Benthic communities at the study sites are characteristic of "clean" water conditions and a detrital-based system.

- Substantial faunal differences exist between the Little Manatee River and Manatee River sites.

4.4 Fish Communities

The assessment of fish communities is important in environmental studies since fish are the segment of the aquatic community most utilized by man, both for food and sport. This study addresses the following elements: species composition, abundance, and biomass.

Methods - Fish were collected by isolating segments of streams with 1/4 inch bar mesh seines. The segments varied between 12 and 35 m in length. All fish between the nets were collected with the aid of a Coffelt Electronics Model BP-2 Electroshocker.

Sampling stations generally corresponded to those utilized for other segments of this study. The length of the stream segments sampled included both "riffle" and "pool" habitats, so Stations 1A and 1B,

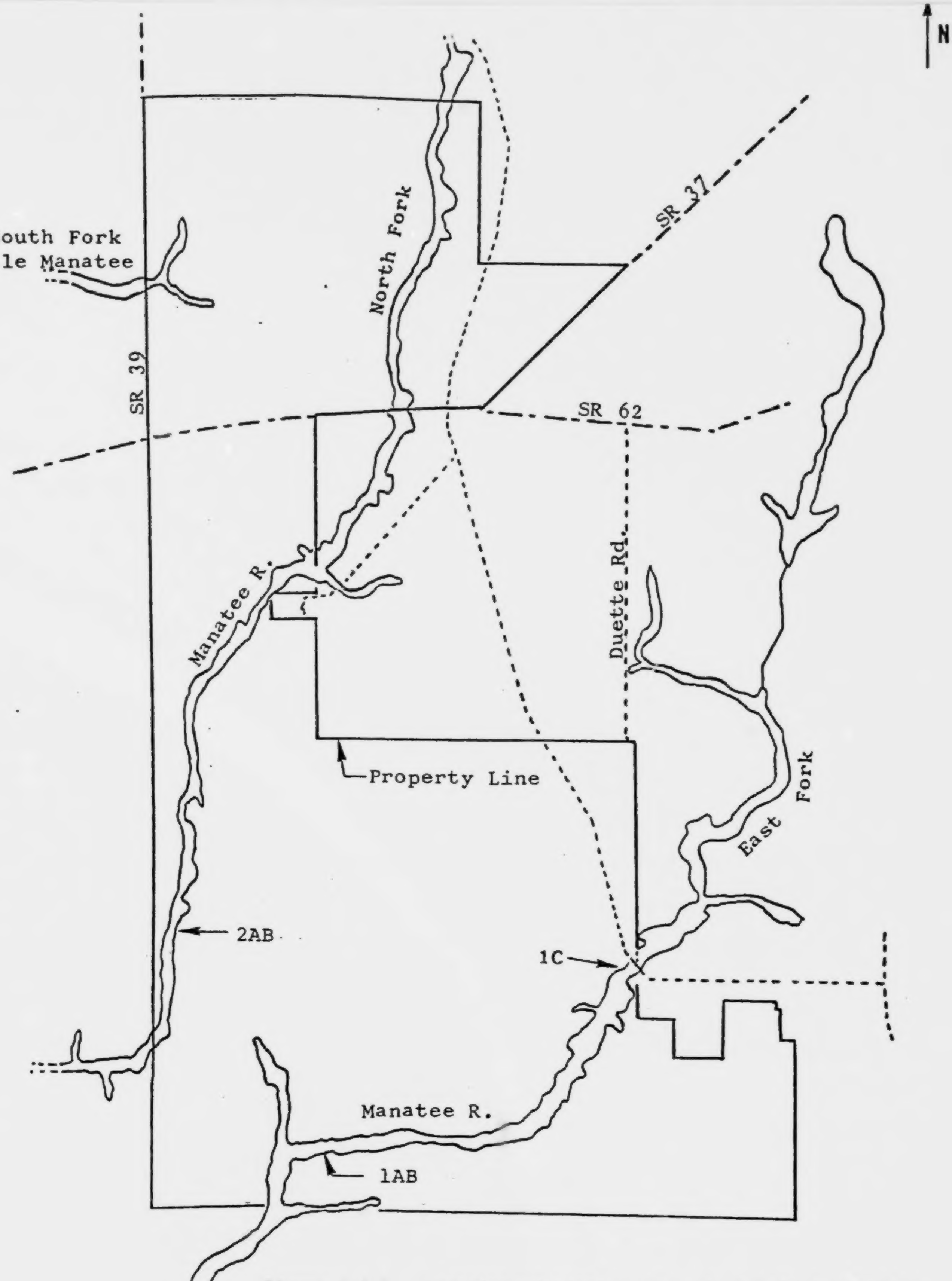

N
South Fork
ttle Manatee
North Fork
SR 37
SR 39
SR 62
Manatee R.
Duette Rd.
Property Line
East Fork
2AB
1C
Manatee R.
1AB

Figure 4.4-1 Location of stations for electroshock sampling.

and 2A and 2B were combined. No samples were taken at Stations 2C, 3A, 3B or 3C because the width of the streams exceeded the length of the seines. The stations sampled were designated 1AB, 1C, and 2AB (Figure 4.4-1).

Specimens were preserved in 10% formalin and later transferred to 40% isopropyl alcohol for storage. Identifications were based on keys and descriptions by Eddy (1969) and Stevenson (1976).

Limitations - Natural populations are subject to temporal and spatial variation. To document these variations would require intensive sampling over an extended period of time (Ricker, 1975). The present study only characterizes the fish communities in general terms.

In addition to problems of fluctuating populations, each sampling method has its own inherent limitations. Trawls, seines, traps, and gillnets are all very size selective (Hamley and Regier, 1973; Ricker, 1975; von Brandt, 1975). Under the conditions present on the Swift property, electrofishing was judged to be the most efficient sampling technique. Mann (1975) also found electrofishing to be the most efficient sampling gear in his studies on hardwater streams in England.

The reaction of a fish to an electrical current depends on its strength (Vibert, 1963; Halsband, 1967). Fish respond to increasing currents in the following sequence:

1. fright
2. forced swimming to positive electrode
3. narcosis
4. pseudo-forced swimming
5. tetany
6. death

The strength of current needed to produce a particular effect is dependant on the species and size of the fish, temperature and the conductivity of the water (Vibert, 1967; Lamarque, 1967). Larger fish are more susceptible and slower to recover than smaller fish (Ellis, 1975a, 1975b; Adams, et.al., 1972).

For this study, high currents were used (300-450 volts, pulsed DC current) in order to capture smaller fish. Even so, some of the smallest fish (<2 cm) probably evaded capture. Where vegetation was heavy (Station 1C) stunned fish may have become entangled in the plants and not surfaced or carried downstream into the nets. Each segment was shocked several times in succession to minimize these problems.

Results - The fishes and invertebrates collected by electroshocking are listed in Table 4.4-A. Sixteen species of fishes and two crustaceans were collected. Station 1C had the greatest number of species for both the winter and summer collections. Ten species were collected at 1C in the winter compared to six species at 1AB and seven species at 2AB. Eighteen species were collected at 1C in the summer compared to three species at 1AB and two species at 2AB. Station 1C also had the greatest number of individuals with 61.51 and 80.57 individuals/10 m (winter and summer, respectively), compared to 9.84 and 0.99 at 1AB and 13.97 and 1.81 at 2AB.

Biomass was less variable than numbers (Table 4.4-B). Station 1C had a biomass of 106.32 g/10 m in the winter and 159.91 g/10 m in the summer, compared to 106.30 and 112.53 at 1AB and 58.12 and 8.06 at 2AB.

Discussion - The North and East Forks of the Manatee River are similar. Both are shallow, low gradient streams shaded by a dense hardwood forest canopy. A distinct channel is usually present. During heavy rains, the

Table 4.4-A Numbers of Fish and Invertebrates per 10 Meters of Stream, Captured by Electroshocker.

Station:	1AB		1C		2AB	
Season :	Winter	Summer	Winter	Summer	Winter	Summer
SPECIES						
Grass shrimp, *Palaemonetes paludosus*	2.46		27.89	5.71		
Crayfish, *Procambarus alleni*			1.64	6.29	2.89	
Golden shiner, *Notemigonus crysoleucas*				0.29		
Ironcolor shiner, *Notropis chalybaeus*				2.57	0.96	
Coastal shiner, *Notropis petersoni*	0.82		4.92	8.00	1.45	
Lake chubsucker, *Erimyzon sucetta*			0.82	1.43		
Brown bullhead, *Ictalurus nebulosus*			0.82	0.29		0.61
Golden topminnow, *Fundulus chrysotus*				0.57		
Flagfish, *Jordanella floridae*				8.57	0.48	
Mosquitofish, *Gambusia affinis*	1.64		14.76	13.14	6.75	1.20
Least killifish, *Heterandria formosa*				1.71		
Sailfin molly, *Poecilia latipinna*				2.57		
Brook silverside, *Labidesthes sicculus*	1.64	0.33		0.29		
Pygmy sunfish, *Elassoma evergladei*	1.64		2.46	6.86		
Warmouth, *Lepomis gulosus*			4.10	2.29		
Spotted sunfish, *Lepomis punctatus*	1.64	0.33	3.28	12.57	0.48	
Largemouth bass, *Micropterus salmoides*		0.33	0.82	1.71	0.96	
Swamp darter, *Etheostoma fusiforme*				5.71		
TOTAL	9.84	0.99	61.51	80.57	13.97	1.81

Table 4.4-B Biomass of Fish and Invertebrates Captured by Electroshocker, Expressed as Grams per 10 Meters of Stream.

Station:	1AB		1C		2AB	
Season :	Winter	Summer	Winter	Summer	Winter	Summer
SPECIES						
Grass shrimp, *Palaemonetes paludosus*	0.74		4.27	2.29		
Crayfish, *Procambarus alleni*			2.30	23.34	2.65	
Golden shiner, *Notemigonus crysoleucas*				1.34		
Ironcolor shiner, *Notropis chalybaeus*				1.89	1.30	
Coastal shiner, *Notropis petersoni*	1.39		9.43	11.49	3.09	
Lake chubsucker, *Erimyzon sucetta*			6.40	24.17		
Brown bullhead, *Ictalurus nebulosus*			4.35	2.74		6.97
Golden topminnow, *Fundulus chrysotus*				0.86		
Flagfish, *Jordanella floridae*				4.77	0.19	
Mosquitofish, *Gambusia affinis*	0.57		6.81	3.91	2.36	1.09
Least killifish, *Heterandria formosa*				0.31		
Sailfin molly, *Poecilia latipinna*				1.43		
Brook silverside, *Labidesthes sicculus*	2.46	0.27		0.23		
Pygmy sunfish, *Elassoma evergladei*	0.25		0.25	1.17		
Warmouth, *Lepomis gulosus*			20.18	29.14		
Spotted sunfish, *Lepomis punctatus*	100.89	25.23	6.89	25.14	2.17	
Largemouth bass, *Micropterus salmoides*		87.03	45.44	22.43	46.36	
Swamp darter, *Etheostoma fusiforme*				3.26		
TOTAL	106.30	112.53	106.32	159.91	58.12	8.06

water rises above the channel banks and covers the wide, heavily forested floodplain. During extremely dry winters, both streams may dry up.

Because of the dense shade, little aquatic vegetation is present in the streams. This has two major consequences: there is little cover available, and the food chain is primarily based on detritus of terrestrial origin.

The fish populations are typical of Barnett's (1972) Narrow Streamlet Habitat. The dominant species are spotted sunfish (Lepomis punctatus) and largemouth bass (Micropterus salmoides). Both fish are predators, the sunfish preying on small fish and invertebrates while the bass feeds on larger fish and invertebrates. The low density of smaller fishes is probably due to the lack of cover which makes them more available to the predators.

Station 1C is an exception to the above remarks. This area has been channelized with the major consequence being that the forest canopy is absent over the stream. The increased sunlight has allowed dense growths of aquatic vegetation, primarily Alternanthera philoxeroides, Potamogeton diversifolia, Nuphar luteum, and Nitella sp.

The diversity of fishes was much higher at this station. As a result of the cover offered by the vegetation, small fishes were abundant. The total biomass, however, was not much greater than at the other stations.

Another study on these streams (Swift, 1978) reports species not caught during this study. They include: Florida gar (Lepisosteus platyrhincus), yellow catfish (Ictalurus natalis), redbreast sunfish (Lepomis auritus), bluegill (Lepomis macrochirus), and dollar sunfish (Lepomis marginatus),

5. RARE AND ENDANGERED SPECIES

Several lists of endangered species are in current use. Those which apply to the Swift mine site are the Endangered Species Act of 1973 (Code of Federal Regulations: Title 50, Chapter I, Part 17), Florida Game and Fresh Water Fish Commission (1976), and Florida Committee on Rare and Endangered Plants and Animals (1976). In addition, the Smithsonian Institution has prepared a list of plants which are proposed for inclusion in the Endangered Species Act list (U.S. Fish & Wildlife Service, 1976). Each list uses the term "endangered" for those species facing the greatest danger of extinction; "threatened" is used for species in less danger. The Florida Committee on Rare and Endangerd Plants and Animals adds the categories "rare" and "species of special concern".

Eighty species which appear on one or more of these lists are known to occur in west central Florida in habitats occurring on the Swift property. These species are listed, with a comment on their probability of occurrence on the Swift site, in Table 5-A. Sixteen endangered, threatened, rare, or special concern species have been observed on the Swift property. The 10 species which are listed as probable are very likely to occur on the property since they have been sighted near the property or they are commensal with the gopher tortoise (which inhabits the site). Those listed as possible have habitat requirements which are met on the Swift property and their known ranges encompass the site. Those listed as improbable either have reported ranges which include west central Florida but not the area of the Swift mine site, or the habitat on the Swift site is only marginally acceptable.

Table 5-A Endangered, Threatened, Rare, and Special Concern Species Observed or Expected on the Swift Property. Sources of Status Determinations:

1. Code of Federal Regulations: Title 50
2. Florida Game & Fresh Water Fish Commission
3. Florida Committee on Rare and Endangered Plants and Animals
4. Smithsonian Institution

SPECIES	HABITAT	STATUS	OCCURRENCE ON SWIFT SITE
PLANTS			
Acrostichum aureum Golden leather fern	Wetlands	Rare[3]	Possible
Asclepias curtissii Curtis' milkweed	Scrub	Threatened[3]	Probable
Asplenium auritum Auricled spleenwort	Freshwater swamp	Endangered[3]	Possible
Bonamia grandiflora	Scrub	Threatened[4]	Possible
Callirhoe papaver Poppy mallow	Longleaf pine Xeric oak, ruderal	Rare[3]	Possible
Centrocema arenicola Butterfly pea	Longleaf pine Xeric oak	Endangered[3]	Possible
Centrogenium setaceum Spurred neottia	Freshwater swamp	Endangered[3]	Improbable
Chionanthus pygmaeus Pygmy fringe-tree	Scrub	Threatened[4] Endangered[3]	Possible
Clitoria fragrans Pigeon-pea	Scrub	Threatened[4] Rare[3]	Possible
Croton elliottii	Pineland	Endangered[4]	Possible
Drosera intermedia Water sundew	Marsh	Rare[3]	Possible
Eriogonum floridanum Scrub buckwheat	Scrub	Rare[3]	Possible
Eryngium cuneifolium	Scrub	Threatened[4]	Possible
Gymnopogon floridanus Beard grass	Longleaf pine Xeric oak	Threatened[4]	Possible

Table 5-A (Continued)

SPECIES	HABITAT	STATUS	OCCURRENCE ON SWIFT SITE
Hartwrightia floridana	Marsh	Threatened[4] Rare[3]	Possible
Hypericum cumulicola Highlands scrub hypericum	Scrub	Endangered[3,4]	Possible
Ilex opaca var. arenicola Scrub holly	Scrub	Threatened[4]	Possible
Lechea cernua Pinweed	Scrub	Threatened[4]	Observed
Lechea divariata Pinweed	Scrub	Threatened[4]	Possible
Liatris ohlingerae Blazingstar	Scrub	Endangered[4]	Possible
Lythrum flagellare Loosestrife	Marsh, River banks	Threatened[4]	Probable
Manisuris tuberculosa Necklace grass	Marsh	Threatened[4]	Possible
Nolina brittoniana Beargrass	Scrub	Endangered[4]	Possible
Ophioglossum palmatum Hand fern	Freshwater Swamp	Endangered[3]	Improbable
Paronychia chartacea Whitlow-wort	Scrub	Endangered[4]	Possible
Persea borbonia var. humilis	Scrub	Threatened[4]	Possible
Platanthera flava Southern tubercled orchid	Freshwater Swamp	Threatened[4]	Possible
Peltandra sagittaefolia Spoon-flower	Freshwater swamp	Rare[3]	Possible
Polygala lewtonii Lewton's polygala	Scrub	Endangered[3,4]	Possible
Polygonella myriophylla Long-leaved jointweed	Scrub	Endangered[4]	Possible
Prunus geniculata Scrub plum	Scrub	Endangered[3,4]	Possible
Rhapidophyllum hystrix Needle palm	Freshwater swamp	Threatened[3,4]	Improbable

Table 5-A (Continued)

SPECIES	HABITAT	STATUS	OCCURRENCE ON SWIFT SITE
Rhynchosia cinera	Scrub	Threatened[4]	Possible
Schizachyrium niveum	Scrub	Threatened[4]	Possible
Scutellaria floridana Skullcap	Longleaf pine flatwoods	Threatened[4]	Possible
Triphora latifolia Nodding-cap	Freshwater swamp	Endangered[4]	Possible
Verbena tampensis Vervain	Sandy hammocks	Endangered[4]	Possible
Warea carteri	Scrub	Endangered[4]	Possible
Zamia integrifolia Coontie palm	Longleaf pinelands, hammocks	Endangered[4] Threatened[3]	Probable
Zephyranthes simpsonii Rain lily	Pine Flatwoods, ruderal	Threatened[4]	Probable
Zephyranthes treatiae Rain lily	Pine flatwoods, ruderal	Threatened[4]	Possible
AMPHIBIANS			
Rana aerolata aesopus Florida gopher frog	Scrub, longleaf pine-xeric oak	Threatened[2,3]	Probable
REPTILES			
Alligator mississippiensis American alligator	Swamp, marsh, stream	Threatened[1,2] Special Concern[3]	Observed
Chrysemys concinna suwanniensis Suwannee cooter	Rivers, streams	Threatened[2,3]	Possible
Drymarchon corais couperi Eastern indigo snake	Sand pine, xeric oak flatwoods, swamps	Threatened[1,2] Special Concern[3]	Observed
Eumeces egregius lividus Blue-tailed mole skink	Sand pine, turkey oak	Threatened[2,3]	Improbable
Gopherus polyphemus Gopher tortoise	Sand pine, Xeric oak, dry flatwoods	Threatened[2,3]	Observed
Neoseps reynoldsi Sand Skink	Sand pine, oak scrub	Threatened[2,3]	Improbable
Sceloporus woodi Florida scrub lizard	Sand pine	Rare[3]	Improbable

Table 5-A (Continued)

SPECIES	HABITAT	STATUS	OCCURRENCE ON SWIFT SITE
Stilosoma extenuatum Short-tailed snake	Longleaf pine Xeric oak	Endangered[2,3]	Possible
BIRDS			
Accipiter cooperi Cooper's hawk	Swamps, mesic hammocks	Special Concern[3]	Possible
Ammodramus savannarum floridanus Florida grasshopper sparrow	Pasture, scrub	Endangered[2,3]	Possible
Aphelocoma coerulescens coerulescens Florida scrub jay	Oak scrub, sand pine	Threatened[2,3]	Observed
Buteo brachyurus fuligenosus Florida short-tailed hawk	Flatwoods, swamps, marshes, unimproved pasture	Rare[3]	Possible
Caracara cheriway auduboni Audubon's caracara	Prairies, pasture	Threatened[2,3]	Observed*
Casmerodius albus Common egret	Marshes, Swamps	Special Concern[3]	Observed
Dendrocopos borealis hylonomis Red-cockaded woodpecker	Mature longleaf pine flatwoods	Endangered[1,2,3]	Improbable
Dendrocopos villosus audubonii Hairy Woodpecker	Woodlands	Special Concern[3]	Probable
Eudocimus albus White ibis	Marshes, swamps	Special Concern[3]	Observed
Falco sparverius paulus Southeastern kestrel	Pine flatwoods, pasture	Threatened[2,3]	Observed
Florida caerulea Little blue heron	Marshes, swamps	Special Concern[3]	Observed
Grus canadensis pratensis Florida sandhill crane	Marsh, wet pastures	Threatened[2,3]	Observed
Haliaeetus leucocephala leucocephala Southern bald eagle	Dense woods near large water bodies	Endangered[1,2,3]	Improbable
Hydranassa tricolor Louisiana heron	Marsh, Swamp	Special Concern[3]	Observed
Ixobrychus exilis exilis Least bittern	Marsh, swamp	Special Concern[3]	Probable

Table 5-A (Continued)

SPECIES	HABITAT	STATUS	OCCURRENCE ON SWIFT SITE
Leucophoyx thula Snowy egret	Marsh, swamp	Special Concern[3]	Probable
Mycteria americana Wood stork	Marsh, swamp	Endangered[2,3]	Observed
Nyctanassa violacea Yellow-crowned night heron	Marsh	Special Concern[3]	Probable
Nycticorax nycticorax Black-crowned night heron	Marsh, swamp	Special Concern[3]	Observed
Pandion haliaetus carolinensis Osprey	Dense woods near large water bodies	Threatened[2,3]	Improbable
Speotyto cunicularia floridana Florida burrowing owl	Pasture, open flatwoods	Special Concern[3]	Observed*
MAMMALS			
Eptesicus fuscus Big brown bat	Mixed forests, abandoned bldg.	Rare[3]	Possible
Felis concolor coryi Florida panther	Forests	Endangered[1,2,3]	Improbable
Mustela frenata peninsulae Florida weasel	Any natural area near water	Rare[3]	Possible
Neofiber alleni Florida water rat	Marsh	Rare[3]	Possible
Peromyscus floridanus Florida mouse	Sand pine, xeric oak, dry flatwoods	Threatened[2,3]	Probable
Plecotus rafinesqui Southeastern big-eared bat	Mixed forests, abandoned bldg.	Rare[3]	Possible
Sciurus niger shermani Sherman's fox squirrel	Woodlands	Threatened[2,3]	Observed
Sorex longirostris longirostris Southeastern shrew	Cypress, hardwood swamps	Rare[3]	Possible
Ursus americanus floridanus Florida black bear	Dense woods	Threatened[2,3]	Improbable

* Observed immediately adjacent to Swift property

PART II - BIOLOGY AND ECOLOGY IMPACT

PART II BIOLOGY AND ECOLOGY IMPACT

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PART II BIOLOGY AND ECOLOGY IMPACT

1. INTRODUCTION

This section describes the effects of mining activities on the natural communities of the Swift Duette Mine Site. These effects are identified as direct or indirect and are addressed in terms of their magnitude, duration (short-term/long-term), and permanence (reversible/irreversible). The significance of these effects is assessed. The effects of mining operations on species of utility to man and on rare and endangered species are addressed separately at the end of this section.

Table 1-A compares the acreages of the present natural communities and those that will survive mining operations or be restored by reclamation.

2. LAND

2.1 Mining

The direct effect of mining will be the physical destruction of much of the present natural vegetation by land clearing/mining activity. The longleaf pine-xeric oak community will be eliminated on-site while the sand pine scrub community will be partially eliminated (Table 1-A). An overall 85 percent loss of native upland vegetation represents the magnitude of mining effects.

It is expected that these effects are largely long-term and irreversible. There are no known instances of these upland communities naturally re-establishing and fully recovering if the soil is radically disturbed. Various authors have assumed that these communities represent seral stages, but nobody had reported the development of these communities. Some of the dominant species readily invade disturbed sites but others (e.g., wiregrass) have negligible reproductive potentials. Reclamation is designed to replace most natural land communities with improved pasture, thereby largely precluding the re-establishment of the original vegetation, even if it were biologically possible to do so.

Not all sites containing native upland communities will be mined. A potential impact on the vegetation of these sites may not be realized until after mining is completed and the site reverts to agricultural use. The remnants of natural vegetation will primarily be small and isolated between swamps and/or improved pastures. Since the natural upland vegetation is dependent on fire for its maintenance, and since fires

Table 1-A Acreages Before Mining and After Reclamation.

	Present Acreages	Acreages After Reclamation
Sand Pine Scrub	73	50
Longleaf Pine-Xeric Oak	35	0
Xeric Oak	518	89
Longleaf Pine Flatwoods	5,673	829
Fresh Water Swamp	1,219	1,228
Fresh Water Marsh	600	864
Cypress Swamp	18	18
Improved Pasture	1,677	6,642
Row Crops	468	107
Orange Groves	113	25
Mixed Forest	0	58
Lakes	0	384
Abandoned Mining Operations	0	100
	10,394	10,394

Data from Swift Agricultural Chemical Corp.
(1977, 1978: DRI-ADA No. 770861 and Addendum).

Acreages after reclamation represent unmined lands that still contain the vegetation present before the commencement of mining operations.

476 acres of natural vegetation lost, mostly from along tributary creeks and bayheads, also from along 4,000 feet of the East Fork Manatee River which will be mined. Fifty-five acres will be recreated by planting saplings of native species at a density of 60 saplings per acre along the recreated East Fork Manatee River.

364 acres of natural vegetation will be lost from mining. Additional undetermined acreages will be disturbed or lost from construction of roads, railroads, pipelines, powerlines, and from the crossing of draglines.

will likely be excluded from the surrounding swamps and pastures, prolonged fire suppression will constitute a long-term or even irreversible impact. This impact will be the product of the plan of reclamation which largely calls for improved pastures.

The significance of mining will be a substantial loss of natural upland habitat and a substantial gain in improved pasture. Timber values are presently small. What little is lost by mining may be offset somewhat by planting pines in understocked pine flatwoods that are not scheduled to be mined. An indirect effect of mining will be that on animal populations which presently depend on the natural upland vegetation in areas to be mined. Animal use is relatively low, as was noted in Section 2.10. Deer, feral hogs, and other larger animals will move into suitable habitats nearby during mining operations. Most suitable habitats are probably understocked, owing to hunting which is an important form of recreation in the region. Mice and other small animals will be less likely to escape and will suffer major reductions in their populations. Some of these smaller species likely will adapt to the habitats created by reclamation and will renew their numbers as those habitats become available.

The destruction of 6,299 acres in natural land communities at the Duette mine may seem relatively minor from a regional standpoint. This loss becomes more significant, though, when viewed in terms of accelerating losses of these same communities elsewhere in Florida and on the entire southeastern coastal plain. Unlike wetland communities, the upland communities are more sensitive to disturbance and much less resilient.

2.2 Other Physical Disturbances

Some acreages containing natural communities are not scheduled for mining but may be effected by related activities. These activities include the "walking" of draglines between mine sites and the construction of roads, railroads, pipelines, and transmission lines. The magnitude of these activities has been estimated for the uplands at 60-65 acres. The degree of disturbance will determine whether or not the vegetation in any localized area will be irreversibly lost or modified, or whether it will recover quickly. Any major disturbance will be a long-term negative impact as no reclamation or other mitigative measures are proposed.

2.3 Mine Pit Dewatering

During mining, the ground-water table will be lowered beneath nearby natural communities which are not scheduled for mining. The water tables will be restored in less than two years as the mined-out pits are filled during reclamation. Water tables presumably will closely approximate their pre-mining levels thereafter, in spite of the utilization of ground water in plant operations.

The magnitude of dewatering would be equivalent to that of severe natural droughts. If rainfall is above normal and frequent throughout the growing season, the lowered water table may have little or no effect on the maintained vegetation. If rainfall is subnormal or irregular, vegetational production (biomass) will be reduced, and some plants may remain dormant for a year or more. Normal growth would be expected to resume as soon as normal water tables are attained, just as growth resumes without ill effect after severe natural drought. This short-term effect may even be less detrimental to animals than to plants. Many animals would adjust by moving a short distance to adjacent areas where more mesic conditions prevailed.

2.4 Air Emissions

Levels of dust and other emissions will increase during mining operations. Other than radioactive nuclides which are treated in another section, the only component of these emissions of potential environmental impact is fluoride. Fluoride toxicity is damaging to plants and animals, varying in degree with the species, the fluoride concentration, and the chemical form of the fluoride. In general, the gaseous fluoride compounds are much more toxic to cattle and other organisms than the insoluble compounds (National Research Council, 1974) as they are more readily absorbed into vegetation. Pines generally are highly sensitive to fluoride toxicity and citrus crops somewhat less sensitive (Treshow and Pack, 1960).

Relatively insoluble fluorides are contained in rock phosphate, which will be a primary source of dust during mining. Gaseous fluoride compounds will not be generated during mining operations, with the possible exception of minute quantities from the driers. The high rainfall in the region will cleanse the vegetation of rock phosphate dust at frequent intervals, thereby reducing the potential for fluoride toxicity. Studies in Polk County (Environmental Protection Agency, 1978) showed that vegetative fluoride content varied with the amount of rainfall, demonstrating this cleansing effect. After entering the soil, fluorides are scarcely if at all absorbed by roots.

Fluoride emissions apparently will constitute a short-term, low magnitude impact that will cease upon the completion of mining operations without residual effects. A possible indirect effect, though should be recognized. Fluoride levels are regionally high, and any increase in fluoride levels may have a cumulative effect of consequence. On the other hand, fluoride levels have been reduced substantially since 1965 in the central Florida phosphate district (Environmental Protection Agency, 1978), and the emissions from the mining operation at Duette would do little to reverse that trend.

Other emissions, including SO_2 and radionuclides, will occur at such low levels as to constitute no discernible impact on the biota.

3. LAND-WATER INTERFACE

3.1 Mining

Mining will destroy at least 476 acres of fresh water swamps and 364 acres of fresh water marshes. The 18-acre cypress swamp will be unaffected (Table 1-A). Reclamation is planned which will restore these acreages and contribute others for a net gain of 15 percent in land-water interface acreage after mining.

The regrowth of fresh water swamps will be slow. Several decades of tree growth are necessary before a mature forest develops. Tree establishment might be delayed in places because of unanticipated problems in stabilizing the substrate of the restored floodplain. Full stocking may be delayed because of the intangibles associated with the natural dispersal of seeds and other propagules from undisturbed floodplains nearby. The initial forest cover will likely resemble that presently occurring on the floodplains of the major streams, rather than those of bayheads. Sweetbay, swamp bay, and other species that are more common in bayheads will likely remain relatively uncommon until peaty acid substrates gradually develop along the minor tributaries.

Fresh water marsh restoration should be much more rapid. Emergent and shallowly submersed aquatics readily invade borrow pits, clay settling ponds, and other newly created marsh habitats on disturbed lands in the region. The problems associated with swamp forest establishment, i.e., slow tree growth, precise substrate requirements, and erratic dispersal of propagules, are not nearly as severe in marsh establishment.

Even though marsh establishment is rapid, there is no guarantee that the initial floristic composition will resemble that of natural marshes. Cattails (Typha domingensis , T . latifolia), which are absent from the natural marshes on the Swift property, typically invade disturbed wet sites where a mat of organic matter is absent and mineral soils are exposed. Cattails are common in borrow pits, ditches, artificial reservoirs, and particularly clay settling ponds. It is likely that cattails will become dominant, perhaps to the exclusion of all other emergent species over wide areas. This effect would occur in the littoral zones of newly created lakes but would be more pronounced in the swales and marshes that will be formed by subsidence at the outlet ends of sand-clay land fills. Once established, dense growths of pure cattails may persist indefinitely, perhaps for decades without replacement by other species, as long as water levels are seasonally deep enough to exclude seedlings of willow, buttonbush and other woody plants.

Pure stands of cattails are less desirable than mixed fresh water marshes in which cattails are either absent or limited to scattered individuals or small patches. Species diversity and richness, in terms of both plants and animals, would be expected to be much greater in a marsh in which most or all space was not preempted by cattails.

Hydrological projections indicate more seasonable stability in the water table than at present. The response of the vegetation to this stability is difficult to predict. The species zones may become more sharply defined. Minor changes in dominance patterns or even composition are possible.

Animal populations closely associated with the shallow marshes will be reduced initially as a result of mining, corresponding with the on-going loss of habitat and the commotion inherent with mining operations. As marsh restoration will also be on-going as part of land reclamation, most or all of these populations should return to pre-mining levels upon the recreation of wetlands' habitats, assuming no interference from cattails.

In summary, the effects of mining on marshes will be short-term with regard to the rapidity of marsh re-establishment on reclaimed lands. The probability of cattails predominating in much of the reclaimed marshland constitutes a long-term adverse impact of low magnitude with regard to species diversity and wild life utilization. This impact would not be adverse with regard to water quality and flow.

There may be an indirect effect on natural marshes that are not scheduled for mining, resulting from the reclamation of mined lands nearby. Shortly after reclamation the sand-clay mix will be five feet above the original grade. This increase in elevation and concomitant base flow might cause these marshes to be more deeply flooded than before mining began. Within a few years the sand-clay mix will have settled to near the original grade, and this effect will disappear. In the meantime, there may be some minor adjustments in the distribution of vegetational zones within the marshes. Some marshes may change somewhat in area. The overall effect would be a short-term impact of low magnitude.

3.2 Other Physical Disturbances

Pipelines, transmission lines, roads, and other structures that may be built across 15-20 acres of wetlands not scheduled for mining will create a disruptive influence on the vegetation. These disturbances will be short-term in places and long-term elsewhere. Unlike in the uplands, swamp and marsh vegetation has the capacity to establish itself readily after stable substrates and suitable hydroperiods are attained.

3.3 Mine Pit Dewatering

Pit dewatering during actual mining will lower the water table beneath nearby natural swamps and marshes that are not scheduled for mining. Plans call for mining one side of a floodplain at a time, thereby depressing water tables minimally. Reclamation immediately following mining will allow the restoration of previous groundwater levels. During dewatering, the lowered water table may have the same effect as a prolonged natural drought. The vegetation will be stressed, especially if rainfall is subnormal during the growing season. Nontheless, these conditions occur naturally about every two decades without long-term harm to the native vegetation.

The drop in the water table will be countered somewhat by water perched by the hardpan following heavy rains. Peaty soils in swamps and marshes will retain moisture well after the mineral soils become dry, thereby protecting dormant rootstocks of herbaceous plants. Precluding a drought during the mining period, rainfall will be sufficient for the needs of epiphytes in swamps.

The cypress swamp will be mined from all sides over a 3-5 year period. The resulting drop in the water table may be more severe than in the fresh water swamps. Cypress trees grow readily when planted on upland sites and would be expected to survive the dry conditions imposed by dewatering. However, if these conditions were to persist until the peaty substrate was dry and compact, some cypress trees might topple from lack of sufficient anchorage.

After reclamation, the predicted high water tables during dry seasons would tend to cause less fluctuation in the water table in the cypress swamp than at present. If this effect also resulted in higher water levels than at present during the growing season, then the understory hardwoods might succumb to the resultant anaerobic conditions. The water-tolerant blackgum might be an exception and in time could conceivably assume codominance with the cypress.

An indirect effect of dewatering would be to increase the possibility of wildfire in swamps. Ignition could result from lightning or from carelessness during mining operations. Such fires would have no appreciable adverse effect on any of the land or land-water interface vegetation except for the fresh water swamps. Fire-tender hardwoods could be killed over wide areas. Cypress trees are fire-tolerant and would be unaffected, unless a ground fire develops in the peat. The possibility of widespread fire is remote, particularly since it would be unable to spread across the many roads, mining pits and other clearings devoid of fuel. Further, the likelihood of ignition of a swamp is unlikely in years of normal rainfall.

3.4 Air Emissions

Fugitive dust and other emissions might possibly have an adverse impact. The comments on dust and emissions in regard to the land communities apply equally to those of the land-water interface.

4. WATER

Various mining activities will result in the destruction, alteration, and/or restoration of existing aquatic habitats as well as the creation of new habitats. Among the new habitats will be several large lakes, a type of habitat not presently existing in the vicinity of the mine site.

4.1 Mining

The direct impact of mining will be the complete destruction of some aquatic habitats, primarily small, intermittent tributaries. The magnitude of this effect is measured by the loss of 417 acres of ephemeral feeder streams and their floodplains. In addition, plans call for mining of approximately 4,000 feet of the East Fork of the Manatee River, one of the major streams on-site.

Mining of the streams will result in the destruction of many of the indigenous animals, although some, especially the fishes, will be able to flee to adjacent, undisturbed areas. Even so, this does not assure their survival. Populations in the adjacent areas are probably already at their carrying capacities and increases in their populations would be countered by increases in predation and disease and a decrease in reproduction. When populations again stabilize, the densities of animals will approximate levels present prior to mining. Thus, there will be a net decrease in numbers proportional to the decrease in habitat.

An indirect effect of mining operations will result from the projected short-term loss of adjacent floodplain forest. This will result in a decrease in the amount of detrital input to the aquatic system. The streams on the site are highly heterotrophic. Detritus from the freshwater swamps is an important source of energy to the streams, the reduction of which will result in a reduction in the carrying capacity downstream.

Swift proposes restoring the mined section of the East Fork and 430 acres of the tributaries. The effect of the restoration is discussed later.

4.2 Other Physical Disturbances

The streams will be crossed at several points by pipelines, permanent and temporary roads, power lines, and a railroad. The draglines will be "walked" across the streams several times. These activities not only result in the destruction of small areas (totaling approximately 15-20 acres) but can also alter the character of the streams for considerable distances downstream.

One effect of these activities near and across the streams is to open the floodplain forest canopy, allowing more sunlight to reach the water. At the present time, the shade from the forest canopy severely limits the growth of aquatic plants. Where breaks in the canopy now occur, there are dense growths of emergent and submerged macrophytes, especially alligator weed (Alternanthera philoxeroides), pondweed (Potamogeton diversifolia), spatterdock (Nuphar luteum), and stonewart (Nitella sp.). These species will expand their populations wherever the canopy is broken. Periphyton will increase because of the increased light and the increase in substrate provided by the aquatic macrophytes.

The change will have positive net impact on small fishes and invertebrates. The macrophytes will provide shelter from predation for insect larvae, crayfish, grass shrimp, and small fishes, allowing them to attain higher densities than in areas devoid of plants. In addition, the periphyton will be an additional source of food for many of these species. The changes will be long-term but will be reversed when new tree growth closes the openings in the canopy (15-20 years).

The increased sunlight reaching the water will also cause a rise in water temperature (Burns, 1972). The change is not expected to be of a magnitude which will significantly effect any of the species now present. Several of the common species inhabiting the Swift site have been reported at temperatures exceeding 30°C: Grass shrimp (Rouse, 1969), flagfish (Tabb and Manning, 1961), Mosquitofish (Bacon et al., 1967; Dahlberg,1972), sailfin molly (Kilby,1955; Tabb and Manning, 1961; Dahlberg, 1972; Mountain, 1972), bluegill (Hickman and Dewey, 1973; Peterson and Schutsky, 1976; Serns and Strawn, 1975), and largemouth bass (Bennett and Gibbons, 1972, 1975; Parrish and Yerger, 1973; Allardi, 1975).

An indirect effect of the stream crossings is an expected increase of erosion. Erosion can also arise from removal of vegetation by the mining operation and piling of overburden in steep spoil banks. But because the mined areas are below grade and perimeter dikes will be built around the actively mined area, most of the runoff in these areas should be contained in the mine pits.

Erosion runoff can cause serious short-term negative impacts largely due to the suspended solids carried by the runoff water. Suspended solids damage aquatic communities by reducing light penetration (thus reducing photosynthetic activity), smothering benthic organisms, destroying spawning areas, and abrading and clogging the gills of fishes (Bennett, 1970; Cairns, Lanza and Parker, 1972; Lackey, 1975). The effects of erosion are quickly reversed following abatement. Barton (1977) reported that erosion from highway construction increased sediment deposition in a nearby stream ten-fold, while suspended solids increased more than two hundred-fold. This resulted in a reduction in the standing crop of fishes immediately below the construction site by more than half. No effects were detected further downstream, however, and population levels at the construction site returned to normal within eight months.

4.3 Mine Pit Dewatering

Little disruption of the flow in the streams is expected due to mine pit dewatering (Ardaman & Associates, Inc., 1975), hence there will be little impact on the aquatic biota. Should a temporary drying of the streams occur, aquatic populations would recover quickly. Kaster and Jacobi (1978) report that invertebrates in a reservoir subjected to a drawdown recovered to the predrawdown level within three months.

4.4 Mine Water Discharge

Discharges into the North and East Forks from the water recirculating system may contain a number of substances which could have subtle impacts on the aquatic biota. Potential pollutants include clay wastes, phosphate, flotation reagents, and sewage effluents. Water samples collected at Swift Agricultural Chemicals Corporation's Silver City Mine (CCI, 1978) showed elevated concentrations of phosphate, ammonia, dissolved solids, fluorides, and zinc. With the exception of ammonia which will not be used in the Duette Mine process, the Silver City Mine effluent may be considered representative of the nature of discharge expected.

Ammonia, fluorides, and zinc are toxic in varying degrees to aquatic organisms (Cairns, Lanza and Parker, 1972; McKim et al., 1976; Herricks and Buikema, 1977). The toxicity of each varies from species to species, but prolonged elevation of concentrations of these chemicals in the streams would lead to a long-term reduction in the diversity of the biota. The infrequent, planned discharges of these chemicals at concentrations comparable to the Silver City Mine effluents should result in minor short-term impacts.

Ammonia and phosphate are plant nutrients. Phosphorus and nitrogen have been identified as the primary nutrients contributing to eutrophication (Brezonik et. al., 1969). However, rivers draining this area of Florida naturally have high phosphorus levels (Dragovich and May, 1962; Dragovich, Kelly and Goodell, 1968). Nitrogen levels in this area are normally low (Dragovich and May, 1962) so that the lack of nitrogen may be limiting to the rate of eutrophication. Eutrophication is a long-term negative impact which is not readily reversed. It usually results in shifts in species composition toward nuisance species and a reduction of diversity.

In summary, a portion of the aquatic environment on the Swift site will suffer outright destruction as a result of mining. The remaining aquatic areas will suffer stresses resulting from changes in temperature, sunlight, erosion, water table drawdown, and the addition of various chemicals. Typical community responses to stress include a reduction in diversity, reflected by a decrease in the numbers of taxa (i.e. Olive and Price, 1978) and the domination of the biota by a few species which may be present in greatly increased numbers (e.g., Eyres, Williams and Pugh-Thomas, 1978).

4.5 Creation of Aquatic Habitat

Phosphate mining will create several deep lakes on the Swift site. This is a significant expansion of the aquatic environment and can be considered a positive impact of mining. Lakes created by phosphate mines are known to support sizeable fish populations (Crittenden, 1965). Species which now occur on the site and which may be expected to expand into this habitat include the Florida gar, golden shiner, lake chubsucker, brown bullhead, mosquitofish, bluegill, largemouth bass, crayfish, grass shrimp and many of the insect larvae.

The segment of the East Fork of the Manatee River and 430 acres of the intermittent streams which are to be mined will be restored. The native fauna should rapidly recolonize this area since aquatic invertebrates (Williams and Hynes, 1977; Chisholm and Down, 1978; Kaster and Jacobi, 1978) and fishes (Gunning and Berra, 1969; Berra and Gunning, 1970) have been observed to recover rapidly in other disrupted streams. Initially, the floodplain forest will be poorly developed, resulting in small detrital inputs and high light intensity. Until the forest canopy becomes well established, aquatic macrophytes and periphyton communities will be well developed. These communities will decline as the shading from the forest canopy increases. Eventually, the restored stream segment should be representative of a natural stream.

5. MITIGATING MEASURES

The mining and reclamation plan incorporates several structural and nonstructural measures intended as safeguards for the environment and biota of the site. These safeguards are treated below under three headings: planned preservation areas, safeguards during mining, and reclamation benefits.

5.1 Planned Preservation Areas

Significant but not obvious mitigating measures associated with the proposed activity are related to the mine planning effort of the applicant. Natural vegetation considered sensitive or unique was specifically identified, ranked, and mapped prior to formulation of the mine plan. Associations marked for prime consideration by the mine planners included the sole cypress stand of the site (18 acres), two stands of sand pine scrub (23 and 50 acres), and the entire floodplains of major streams, as identified by the dominant vegetation.

As proposed in the mine plan of the applicant, the cypress stand is entirely excluded from the mining plan, as is the larger stand of sand pine scrub. The wooded floodplains of the major streams are also excluded with the exception of a three-quarter mile segment of the East Fork Manatee River which is proposed for mining and subsequent reclamation as a swamp.

In addition to preservation of the above described areas, the environmental value of 829 acres of pine flatwoods not scheduled for mining will be improved. These flatwoods have remained understocked with pines ever since the original timber harvest several decades ago. Seedling pines will be planted at a density of 100 per acre in an attempt to re-establish the original forest cover.

5.2 Safeguards During Mining

The quantity of fugitive dust that could settle on the vegetation in the vicinity of mining operations will be reduced by spraying water regularly on the well traveled roads. Air emissions will be kept within applicable standards further protecting the biota that is not disturbed or destroyed by mining.

Exposed soils of reclamation areas will be planted with cover crops as soon as possible to prevent erosion and consequent sedimentation in streams.

In-system water recycling and the attendent minimization of water discharges from the plant and settling pond will reduce the potential for water pollution both on-site and elsewhere. If excessive water accumulates after exceptional rainfall events, this excess will be diverted into clarification ponds before it is released into natural streams. Water quality will be monitored daily at permanent stations to insure that discharges into streams meet applicable standards.

In an effort to protect wetlands along streams, the mine plan incorporates active mining along only one side of a wetland at a time. The mine pit will be filled before the other side is mined. As a result, the base flow of ground water into these wetlands will never be severed entirely and the potential for the wetland vegetation suffering from water-stress during mining will be reduced.

Mining will not take place within 200 feet of any vegetated floodplain, except the segment of the East Fork Manatee River that will be mined. As a result, base flow into streams will be maintained at near normal levels even on the side of a stream being mined. On the long-term, it is estimated that base flow that enters streams will be reduced by no more that 1.5 percent after reclamation.

The possibility of leakage from pipelines crossing natural streams will be reduced by the use of retention dikes at the outer edges of floodplains and by the construction of double walled, trestled pipelines over floodplains. If leakage should occur, it will be detected quickly by an alarm system that is activated with a change in pressure in the pipeline.

The mining of the East Fork Manatee River will be mitigated by the prior diversion of stream flow through a newly created meandering stream bed and 55 acres of floodplain. This new floodplain will have been planted initially to grasses for soil stabilization and then to native bottomland hardwood trees, with hopes of speeding forest development. There will be no mining upstream until the new channel has been properly established. As a result, water quality downstream will not be degraded.

5.3 Reclamation Benefits

All reclaimed land will be revegetated to minimize erosion. Physical land restoration will be completed within three years after the inception of mining in a given area (one year for mining and two years to fill in mine pits with tailings or a sand-clay mix). Water tables nearby, which will be depressed within 800 feet of an active mining pit, will be re-established essentially at previous levels after reclamation. This effect will be immediate, because the pits will be filled by an aqueous slurry of tailings and sand-clay mix. As a result, the natural vegetation of surrounding unmined areas will not suffer prolonged water-stress, if any at all.

The sterile, excessively drained sand tailings fill areas will be spread with overburden or sand-clay mix, which have better soil characteristics allowing faster revegetation. Reclaimed lands will be planted to a sod of Bermuda grass, bahia, and white clover, which will promote the rapid incorporation of organic matter and thus the development of a topsoil. Hedgerows of native trees will be planted on about one percent of this land, providing escape cover for wildlife. Patches of Eucalyptus will also be planted to serve as cattle shade.

The re-establishment of swamps and marshes is a major feature of the reclamation plan of the applicant. Fifty-five acres will be planted to native bottomland hardwoods at a density of 100 trees per acre in the reclaimed East Fork Manatee River after mining. Minor tributary creeks leading to the larger streams will largely be mined. They will be replaced by an additional 430 acres of reclaimed lands which will be planted to native bottomland hardwoods. The native marshes occuring in flatwoods depression that will be lost during mining will be replaced by similar depressions on reclaimed lands. These depressions will be allowed to revegetate by natural means into marshes. There will be a net gain of nine acres of fresh water swamps and 264 acres of fresh water marshes after reclamation.

These marshes and swamps are to be located so that they may serve as clarification and nutrient filtration areas for runoff before entering the major streams. They also form a continuous network of native vegetation which will serve as corridors for wildlife. Mine pit lakes resulting from reclamation are integrated with these corridors.

These reclaimed lakes will contain a substantial littoral zone (approximately 10 percent of lake area) which will enhance their biological productivity. A 100 acre area adjacent to the northernmost reclamation lake will intentionally be left largely unreclaimed. The series of steep windrows of spoil will be topped and allowed to revegetate by natural means and in time will serve as roosting areas for water birds. The rugged terrain will discourage predators (and people) from disturbing these roosts.

6. ENVIRONMENTALLY SENSITIVE AREAS

6.1 Baseline

This section assigns environmental sensitivity values to the various attributes of each community. The more sensitive communities are identified.

An area can be considered sensitive if it meets one or more of the following criteria:

- Contains endangered or threatened species which cannot survive elsewhere.
- Fulfills an important function, such as aquifer recharge or high wildlife production.
- Represents a unique or rare community habitat in west-central Florida.

The term, environmentally sensitive area, as used in this EIS, pertains to a habitat or plant community, rather than to a specific locality containing one or more habitats or communities. Environmental sensitivity in this section of the EIS is defined on the basis of present environmental values, not on potential values if land usage were to change nor on values accruing from reclamation after mining.

A community (or habitat) may be environmentally sensitive in regard to some attributes, but insensitive for others. The overall environmental sensitivity of a community depends in part on the importance of each attribute in the eyes of the evaluator.

Methods - Twelve attributes were evaluated for each natural plant community and for the three major ruderal habitats (improved pasture, cropland, citrus groves). These attributes were: water storage, aquifer recharge, water quality, erosion control, grazing, endangered species habitat, vertebrate production, timber, fishing, hunting, aesthetics, and fire breaks. Camping, hiking, and other attributes were omitted because they do not represent land use practices or natural processes currently associated with the Swift property.

The environmental value of each attribute for each community was determined by concensus among five scientists who conducted field investigations on the Swift property. The evaluations were made according to the following scale:

1 High positive value
2 Low positive value
3 Neutral; without effect with regard to the attribute
4 Low negative value
5 High negative value

The assignments of some values were particularly judgmental for lack of sufficient observations or data.

Results and Discussion - The evaluations are presented on cut-away diagrams (Figures 6.1-2) based on a transect through the Swift property, shown in Figure 6.1-1. Some attributes are narrow in scope (e.g., hunting), while others are broader (e.g., vertebrate production). Some communities are rare on the Swift property, while others cover large areas. Because of such differences in scope and area, the environmental sensitivity of a community cannot be ascribed as the average value of its attributes. As a result, no such averages are presented. The remainder of this section elaborates on the criteria used for assigning values for five of the 12 attributes. The criteria for the assignment of values for the other eight attributes are evident from the information given in Part I.

Water Storage: Wetlands are generally considered prime water storage areas during dry seasons. Streams are exceptions, because they export water when the water table is above the level of the stream bed. If wetlands are indeed water storage areas, then it follows that during dry seasons the water table is higher in wetlands than in adjacent uplands. In the region of the proposed mine, though, the water table is probably higher in the soils of the adjacent uplands. The water of marshes and hardwood swamps is merely the result of base flow of the groundwater from adjacent areas. The water table of wetlands is exposed and, therefore, subjected to loss through evapotranspiration. Such a loss in water is not characteristic of the adjacent uplands, because soil water does not rise through the sands to the surface by capillarity (Woods, 1957) and because the feeder roots (responsible for water absorption) are nearly all superficial. (Soil saturation and resultant oxygen depletion in the summer wet season prevent root growth into lower soil levels.)

Cypress swamps may be exceptional because the shade from cypress trees reduces evaporation from the pond surface (Odum, 1976), and perhaps because water absorption and thus transpiration are reduced by the high acidity of cypress ponds. The values in Figure 6.1-2 reflect these considerations.

Aquifer Recharge   Figure 6.1-4 shows a neutral value of 3 for all communities, because available evidence indicates that there is minimal recharge occurring on the proposed mine site. Ardaman & Associates, Inc. (1975) wrote, "The surface drainage pattern indicates that there is no significant recharge to underlying aquifers either through sinkholes or areas of highly pervious soil." William F. Guyton & Associates (1975) said that recharge of the confined Floridan aquifer sometimes occurs only at remote localities within a large region. Ewel (1976) said that most cypress heads in peninsular Florida were underlain by confining beds of clay which prevented recharge of the Floridan aquifer.

Water Quality: Water quality values were assigned on the basis of potability. Fecal matter from cattle was considered the most negative influence on water quality. The soils of natural communities do not degrade water quality and may improve it by the absorption of ions to their colloidal surfaces. The stream is considered neutral. Heterotrophic metabolism likely results in the mineralization of nutrients which go into solution, degrading water quality. This effect may be slight because of the low metabolic rates in streams and may be offset by the oxygen added by agitation of the flowing water.

Erosion Control: Erosion is a continual process in flowing streams. Streams are given high negative values for erosion control, accordingly. Natural communities are characterized either by standing water or by dense superficial root mats that bind the soil. These are given high positive values for erosion control. Freshwater swamps are exceptions over long time spans, because colluvial transport occurs and gradually enlarges valleys. Improved pastures are likely subject to some erosion due to a less effective root mat than in natural communities and to soil exposure caused by trampling.

Vertegrate Production: The values for this attribute are indicative of the relative biomass of all non-domestic vertebrate animals. This attribute is difficult to evaluate for the paucity of data and because of the propensity of many animals to forage in two or more communities.

Identification of Sensitive Habitats

Rare and Endangered Species: A habitat or community can be considered sensitive if it harbors rare and endangered species, particularly if these species are unable to survive and reproduce in any other kind of habitat. Sixteen rare and endangered species were observed on the Swift property (Table 5-A, Part I). None of them are confined to a single community in central Florida. The scrub jay and pinweed both occur in the sand pine scrub community and the xeric oak community. Fox squirrels inhabit a variety of woodlands. Alligators, gopher tortoises, indigo snakes, and ten species of wading birds and raptors occur in a variety of habitats, including abandoned or reclaimed phosphate mines. None of the habitats at the proposed mine site can be identified as being particularly sensitive on the basis of the rare and endangered species seen in them.

Fulfillment of an Important Function: The cutaway diagram (Figure 6.1-2) shows that each community performs some beneficial "services". No community or communities stand out as being far superior to the others, and none are particularly inferior. A reason for this apparent equity is that the properties that combine to make a community superior for one function may make that community inferior for another function.

Another reason is that the cutaway diagrams show the positive values of a community but not the negative values that would accrue if that community were to be destroyed. Outstanding in that regard is the fresh water swamp community. Swamps bordering streams on the Swift property function to check erosion, to filter-out impurities from the flow of gravitational water, to contribute the organic matter that forms the basis of the heterotrophic aquatic community of the stream, to shade the stream thereby controlling the levels of aquatic macrophytes and the diurnal fluctuations of water temperature. The swamps are also frequented on occasion by various animals that spend most of their time in other terrestrial communities but depend on swamps for food, breeding, or to avoid predation.

The destruction of a swamp forest has a profound effect on water quality downstream, on aquatic communities in the streams, and on populations of terrestrial animals that primarily inhabit other communities. These and other negative impacts caused by the destruction of swamps are listed in the regulations pertaining to Section 404 of the Federal Water Pollution Control Act, published July 19, 1974 (Federal Register 42(138): 37136).

For these reasons the Fresh Water Swamp community is designated as environmentally sensitive.

Unique or Rare Communities: The sand pine scrub community is the only one on the Swift property that is not particularly abundant in west central Florida. It occurs only in Florida and in one adjacent county in Alabama. It is distributed irregularly and often in small stands.

Many or most of these stands have been destroyed and the sites converted to citrus groves or urban developments. Some of the component species aggressively invade culturally disturbed sites, but active seral development that leads to the establishment of the entire community has not been observed. Present evidence suggests that the community is relictual and that its destruction constitutes an irretrievable loss of habitat.

The sand pine scrub community is not under immediate threat of extirpation in west central Florida, and many small stands are scattered over the landscape. As more of these stands are destroyed, the individual losses will be increasingly felt. These losses may have an adverse effect on rare and endangered species. Many of the rarer plant species are indigenous only to the sand pine scrub community (Table 5-A, Part I).

In summary, the sand pine scrub community may be considered to be marginally sensitive and will become more so as future land use impinges on its habitat.

LEGEND

Figure 6.1-2. Environmental sensitivity values for various attributes. Values range from 1 (high positive value) to 5 (high negative value), as described in the text. The transect which the cut-away diagram portrays is shown in Figure 6.1-1. The cut-away diagram is drawn to generally represent the size relationship of the various areas. Environmental sensitivity values for the xeric oak community also apply to the longleaf pine-xeric oak community which is not shown.

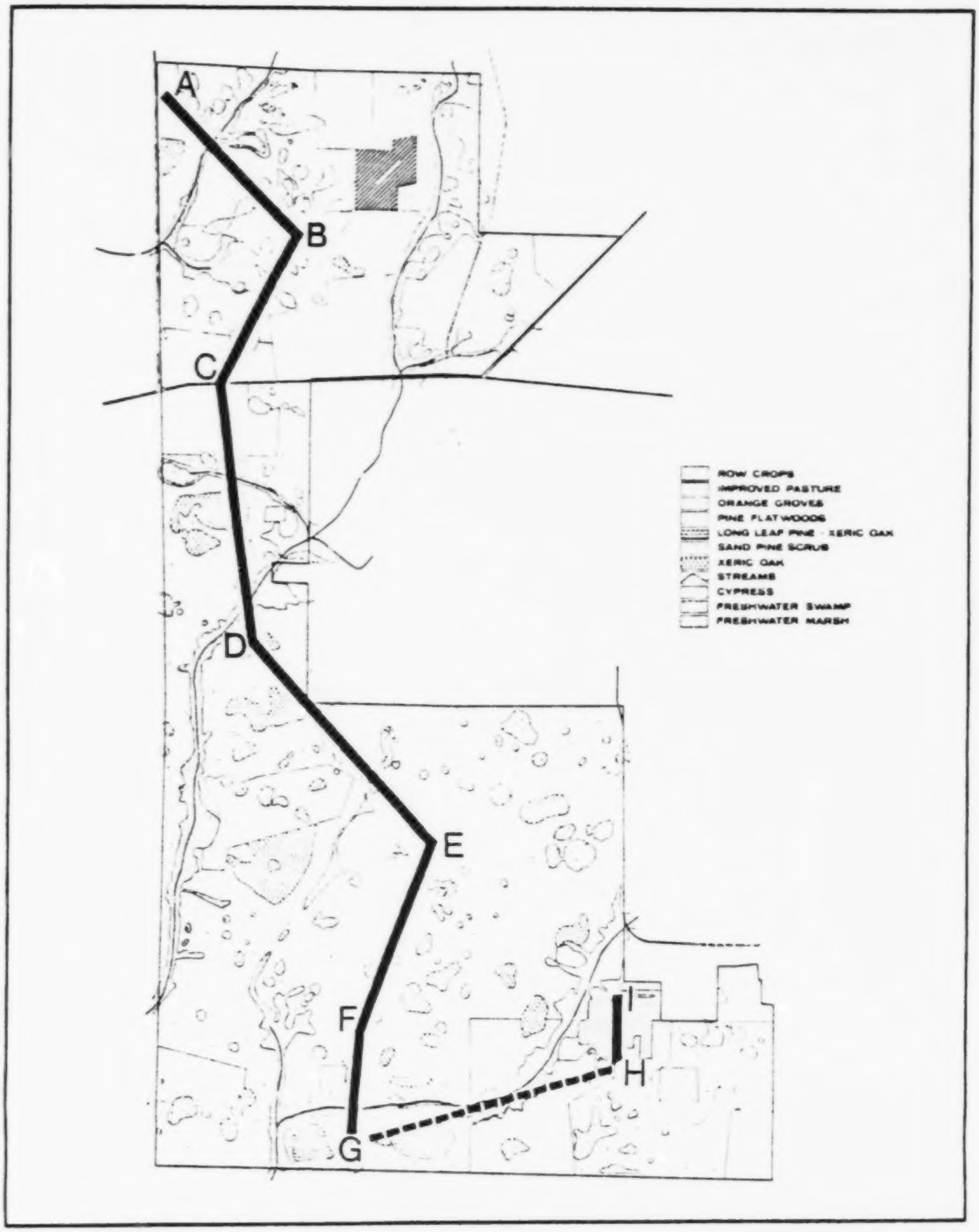
A
B
C
D
E
F
G
H
I
ROW CROPS
IMPROVED PASTURE
ORANGE GROVES
PINE FLATWOODS
LONG LEAF PINE - XERIC OAK
SAND PINE SCRUB
XERIC OAK
STREAMS
CYPRESS
FRESHWATER SWAMP
FRESHWATER MARSH

FIGURE 6.1-1 TRANSECT LINES Source: Conservation Consultants, Inc.	U.S. EPA - REGION IV DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR SWIFT AGRICULTURAL CHEMICALS CORPORATION PROPOSED DUETTE MINE MANATEE COUNTY, FLORIDA

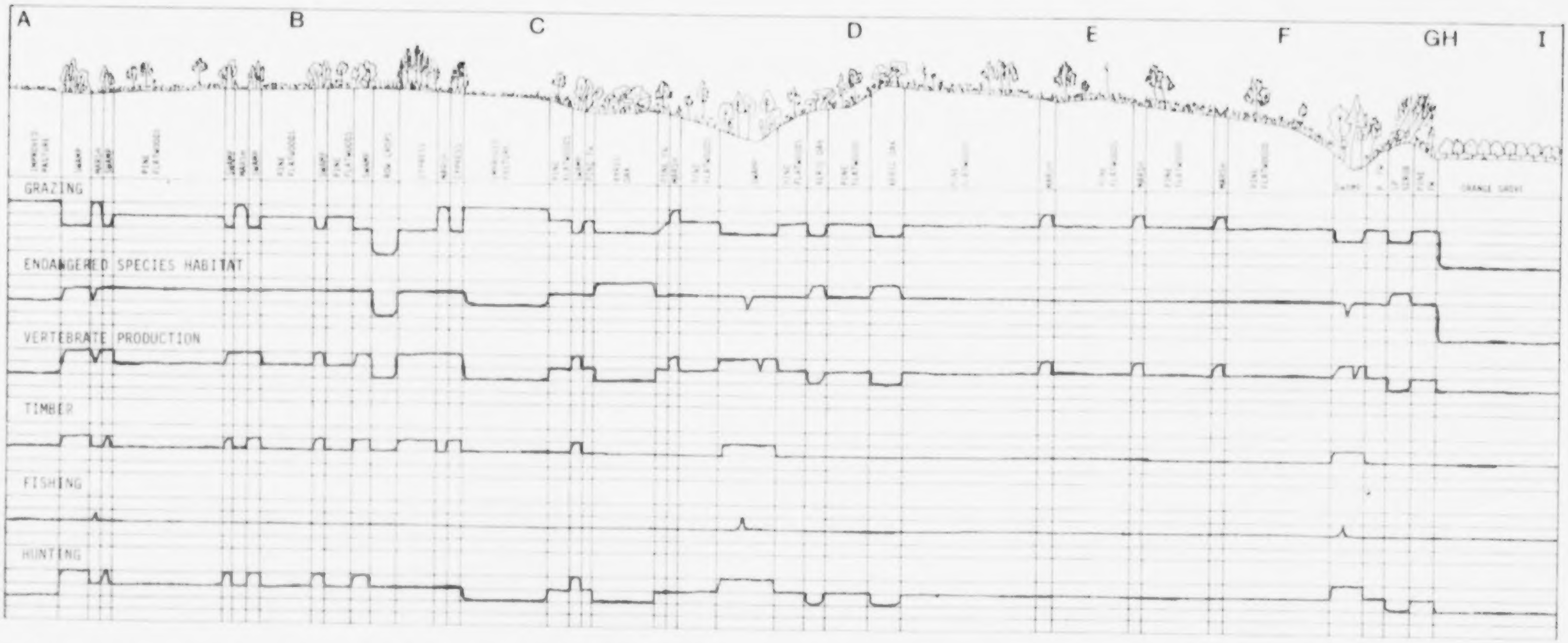

Figure 6.1-2 Habitat Cross Section and Environmental Value - before mining

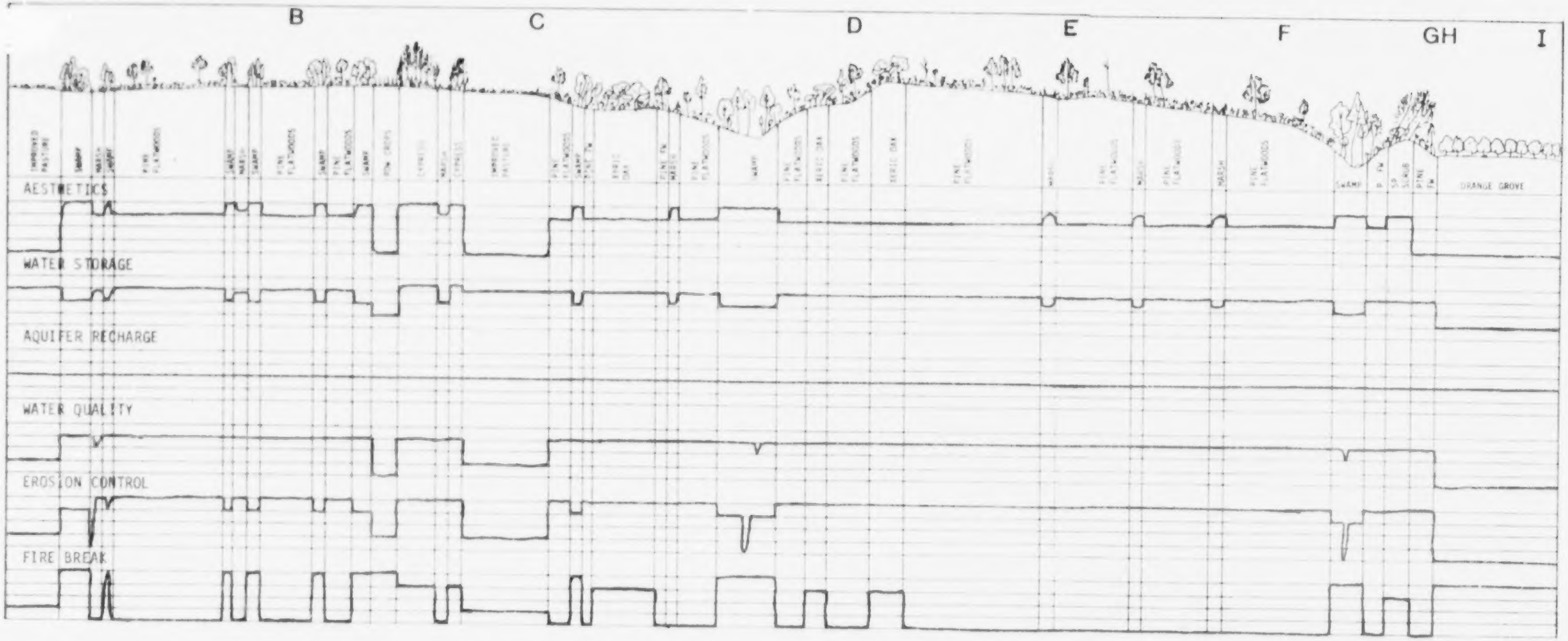

Figure 6.1-2 (cont.) Habitat Cross Section and Environmental Value - before mining

6.2 Impact

This section presents the presumed environmental values for the habitats that will exist after mining and reclamation. The same attributes that were assessed for their present environmental values in Section 2.11 are evaluated in this section. These attributes are grazing, endangered species habitat, vertebrate production, timber, fishing, hunting, aesthetics, water storage, aquifer recharge, water quality, erosion control, and fire break.

Methods - The attributes were evaluated in the same manner as described in Section 6.1.

Results and Discussion - The evaluations are presented on cut-away diagrams (Figures 6.2-1). These diagrams are based on a transect that follows approximately the same route as that shown in Figure 6.1-1 but with these exceptions: the streams are not crossed; row crops, orange groves, and the sand pine scrub community are not transected; and three new habitats are shown which are not part of the present landscape: lakes, wilderness area, and mixed forest. The xeric oak community does not appear on the diagram, because it will be eliminated entirely by mining.

The same environmental values that were assigned to a given habitat in Figure 6.1-2 were reassigned in Figure 6.2-1. It was assumed that there would be no changes in these values after mining, at least for sites that will not be mined. It is questionable as to whether or not the swamps and marshes that will be created on mined and reclaimed lands will have the same environmental values that were assigned to swamps and marshes. Natural habitat restoration as proposed for the Swift site has not been attempted previously. Prototypical studies are being initiated on some mined lands in central Florida, but the results are not yet available. It would be improbable that the restored marshes would have the exact species composition and dominance patterns as in natural marshes, at least initially.

The question arises, for example, as to the importance of cattails on the newly created marshes. Cattails were absent on the natural marshes studied on the Swift property, but they dominate the marshes of abandoned clay settling ponds throughout the central Florida phosphate district. Since cattails aggressively invade ditches, reservoirs, and other newly created wet sites with mineral substrates, it is possible that they will be important in the newly created marshes on the sand-clay fills proposed for the Swift property.

Since there is no method of determining with confidence the environmental values of newly created swamps and marshes on reclaimed lands, one can only assume that the environmental values of natural habitats are coincident with those of recreated habitats.

Some of the evaluations require explanation, as follows:

- Lakes - The emergent and shallowly submerged aquatic plants of the littoral zone will be utilized by cattle, thus a grazing value is appropriate, although lower than that of the improved pastures that these lakes replaced. Lakes will attract wood storks, the large wading birds of special concern, alligators, perhaps eagles, and other rare and endangered species. The biomass of fish and reptiles and their high turnover rates contribute to high vertebrate productivity. The timber value is rated low, rather than neutral, because presently wooded habitat is being replaced by lakes. The water storage value is better than that of swamps and marshes because of a better surface-to-volume ratio, less emergent aquatic vegetation that promoted transpirational losses, and probably a partial cover of water hyacinths that will reduce evaporation. The banks will be subject to wave action, causing some erosion.

- Wilderness Area - The wilderness area will consist of spoil piles which will be allowed to become revegetated by natural means. The vegetation of similar sites throughout the central Florida phosphate district consists of woodlands which do not closely resemble any indigenous plant communities in structure or species composition. The term "wilderness" as used in the reclamation plan refers to unmolested second-growth and not to the definition of wilderness in the Wilderness Act of 1964, which created the National Wilderness Preservation System.

  Gross production will be relatively low because of the sparse growth of brushy vegetation that will occupy these slopes for at least several decades. The steepness of the slopes will retard the establishment of more luxuriant vegetation. This vegetation will have a low aesthetic value. The angle of slope will cause continual erosion in wet seasons. Vertebrate production may be high, either from nesting birds attracted to the lake and partially isolated from predators, or from rodents that are also partially isolated from predators.

- Mixed Forest - The values for this habitat are about the same as those for other wooded habitats. The value for grazing is high and that of fire break capacity low, assuming incomplete canopy closure and a grassy undergrowth.

LEGEND

Figure 6.2-1. Environmental sensitivity values for various attributes. Values range from 1 (high positive value) to 5 (high negative value). See test for further explanation.

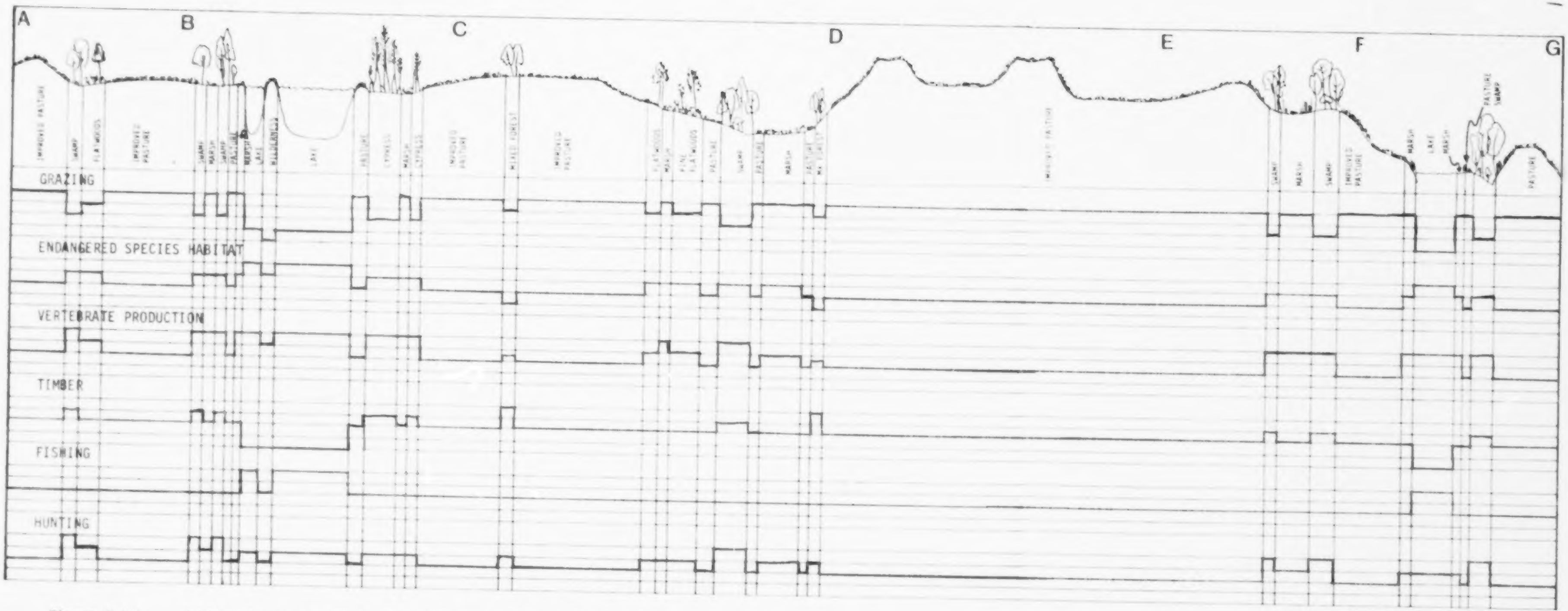

Figure 6.2-1 Habitat Cross Section and Environmental Value - after mining

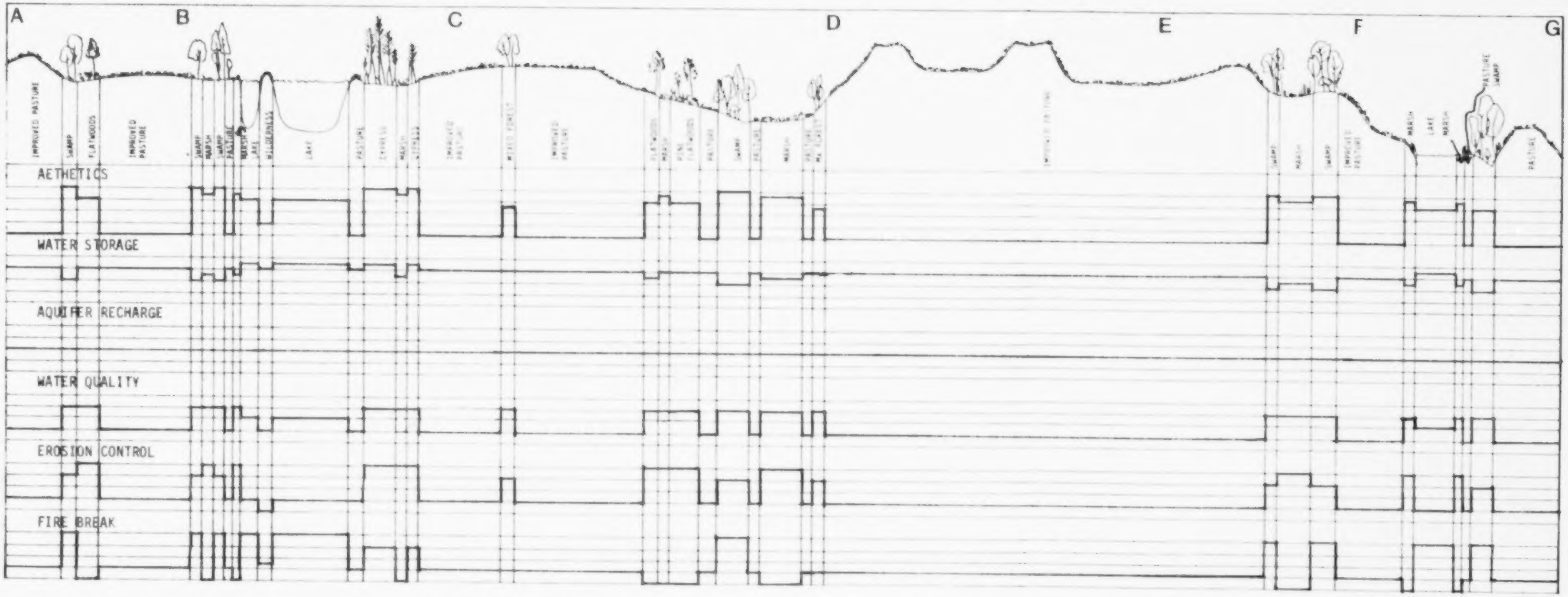
A
B
C
D
E
F
G
IMPROVED PASTURE
SWAMP
FLATWOODS
IMPROVED PASTURE
SWAMP
MARSH
SWAMP
PASTURE
MARSH
LAKE
WILDERNESS
LAKE
PASTURE
CYPRESS
MARSH
CYPRESS
IMPROVED PASTURE
MIXED FOREST
IMPROVED PASTURE
FLATWOODS
MARSH
PINE FLATWOODS
PASTURE
SWAMP
PASTURE
MARSH
PASTURE
MX FOREST
IMPROVED PASTURE
SWAMP
MARSH
SWAMP
IMPROVED PASTURE
MARSH
LAKE
MARSH
PASTURE SWAMP
PASTURE
AETHETICS
WATER STORAGE
AQUIFER RECHARGE
WATER QUALITY
EROSION CONTROL
FIRE BREAK

Figure 6.2-1 (cont.) Habitat Cross Section and Environmental Value - after mining

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APPENDICES

Appendix I. Data from periphyton and benthos studies.

- Table 1. Periphyton Abundance (number of cells/mm^2) and Species List for Winter (W) and Summer (S) Sampling Periods, (1978).
- Table 2. Composite Species List for Ponar Grab and Hester-Dendy Samples for the Winter (W) and Summer (S) Sampling Periods, (1978).
- Table 3. Composite Species List for Ponar Grab Samples for the Winter and Summer (S) Sampling Periods, (1978).
- Table 4. Composite Species List for Hester-Dendy Samples for the Winter (W) and Summer (S) Sampling Periods, (1978).

Appendix II. Taxonomic references for algae and benthic organisms.

Table 1 . Periphyton Abundance (number of cells/mm^2) and Species List for Winter (W) and Summer (S) Sampling Periods (1978).

Species	Sta 1A		Sta. 1B		Sta 1C		Sta 2A		Sta 2B		Sta 2C		Sta 3A		Sta 3B		Sta 3C	
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
CHLOROPHYTA																		
Ankistrodesmus sp. A.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	17
Ankistrodesmus sp. B.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Bulbochaete sp.	0	0	0	*	0	0	0	*	0	*	0	0	0	0	0	0	0	0
Characium sp.	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coccoid green sp. A.	0	230	5	33	3	1	0	0	0	0	5	0	1	1	0	0	4	4
Coccoid green sp. B.	0	2	0	1	14	42	1	1	0	0	3	1	0	1	0	0	0	4
Cosmarium sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	6
Desmidium sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Euastrum pectinatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Filamentous green sp.	0	1	9	1	3	0	0	0	0	1	54	0	0	3	16	1	0	10
Micrasterias radiata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Micrasterius sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mougeotia sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2
Pediastrum sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Scenedesmus sp. A.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
Scenedesmus quadricauda	0	1	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	4
Spondylosium sp.	0	0	0	0	0	0	0	0	0	0	6	0	6	0	0	1	17	0
Spyrogyra sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Starastrum sp.	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1

Table 1 (Continued)

Species	Sta 1A		Sta. 1B		Sta 1C		Sta 2A		Sta 2B		Sta 2C		Sta 3A		Sta 3B		Sta 3C	
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
CHRYSOPHYTA																		
Achnanthes sp. A.	0	2	2	3	0	7	0	0	0	1	10	1	1	7	7	3	77	64
Achnanthes sp. B.	0	3	0	4	9	23	0	2	4	0	11	23	23	3	0	1	0	82
Achnanthes sp. C.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	117
Cocconeis sp. A.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cocconeis sp. B.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Cocconeis scutellum	0	1	0	3	0	5	0	1	0	0	0	0	0	1	0	0	0	0
Cymbella sp.	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	5
Dinobryon sp.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Eunotia pectinalis	4	1	5	6	5	6	4	0	7	0	4	0	0	0	0	1	0	15
Frustalia rhomboides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Gomphonema sp. A.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0
Gomphonema sp. B.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Licmorpha sp. A.	0	4	0	3	3	1	0	0	0	0	0	0	5	0	0	0	0	4
Licmorpha sp. B.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Navicula sp. A.	0	1	0	1	7	14	0	0	0	1	0	0	0	0	0	0	1	109
Navicula sp. B.	0	1	1	1	0	2	0	1	0	0	0	0	0	0	0	1	1	2
Nitzschia sp. A.	0	0	0	2	0	1	0	0	1	0	0	0	0	0	0	0	0	0
Nitzschia sp. B.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12

Table 1 .(Continued)

Species	Sta 1A		Sta. 1B		Sta 1C		Sta 2A		Sta 2B		Sta 2C		Sta 3A		Sta 3B		Sta 3C	
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
Ophephora marytii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33	0
Pennate sp. A.	1	3	0	3	0	1	0	1	0	0	0	0	6	0	0	0	0	4
Pennate sp. B.	0	0	0	1	0	0	0	0	0	0	0	0	4	0	0	0	0	0
Pennate sp. C.	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	64
Pleurosigma sp.	1	0	0	0	0	1	0	0	0	0	0	0	0	2	1	2	0	8
Synedra pulchella	30	28	16	18	33	35	12	3	3	4	11	2	45	13	73	6	62	66
Synedra ulna	1	0	1	0	0	0	4	0	0	0	0	0	4	0	3	0	16	0
Synedra sp. A.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
CYANOPHYTA																		
Anabena sp.	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Nostoc sp.	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Merismopedia sp.	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	1
Oscillatoria sp. A.	0	168	1	107	0	31	0	8	0	14	11	6	1	1	0	2	0	13
Oscillatoria sp. B.	0	0	0	0	14	0	0	0	0	0	0	1	0	1	0	0	0	0
EUGLENOPHYTA																		
Euglena sp.	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Phacus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
RHODOPHYTA																		
Batrachospermum sp.	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Number of Cells/mm^2	37	450	40	192	92	181	22	17	15	21	125	34	97	34	101	18	225	640
Number of Species/Station	5	17	8	22	10	21	5	8	4	6	10	6	11	11	6	9	14	32

Table 2 . Composite Species List for Ponar Grab and Hester-Dendy Samples for the Winter (W) and Summer (S) Sampling Periods, 1978.

SPECIES	Sta. 1A		Sta. 1B		Sta. 1C		Sta. 2A		Sta. 2B		Sta. 2C		Sta. 3A		Sta. 3B		Sta. 3C	
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
COELENTERATA																		
HYDROZOA																		
Hydra sp.	2	0	2	1	3	4	1	0	0	0	2	0	119	0	42	2	58	1
PLATYHELMINTHES																		
TURBELLARIA																		
Unidentified sp.	3	0	1	11	2	3	2	0	0	0	11	11	2	0	0	0	41	7
RHYNCHOCOELA																		
Prostoma rubrum	0	0	0	6	13	9	1	1	0	2	0	0	0	0	0	0	0	0
ANNELIDA																		
Oligochaeta sp.	58	44	33	162	580	1224	50	241	179	195	315	126	594	311	445	630	1545	1203
HIRUDINEA																		
Unidentified sp. A	3	0	0	2	0	1	0	0	5	0	177	46	6	4	0	6	0	1
Unidentified sp. B	0	0	0	0	0	0	0	0	0	0	11	0	4	0	0	0	1	0
Unidentified sp. C	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
MOLLUSCA																		
BIVALVIA																		
Elliptio sp.	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0
Eupera cubensis	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Musculium sp.	3	5	3	13	1	9	20	2	1	7	0	0	2	12	0	14	0	0
*Pisidium-Sphaerium**	26	13	1	9	8	51	42	32	20	62	0	0	59	160	0	80	0	0
Uniomerus obesus	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
GASTROPODA																		
Amnicola (s.g. Lyogyrus) retromargo	1	0	0	1	0	5	0	0	0	0	0	0	0	0	0	0	0	0
Ferrissia sp.	0	1	0	3	1	3	3	39	1	5	15	15	148	1	55	2	2	83

Table 2 . Continued.

SPECIES	Sta. 1A		Sta. 1B		Sta. 1C		Sta. 2A		Sta. 2B		Sta. 2C		Sta. 3A		Sta. 3B		Sta. 3C	
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
Gyraulus sp.	0	0	0	0	8	7	0	2	0	7	0	0	5	3	14	13	1	1
Helisoma duryi	0	0	0	0	0	0	1	0	0	0	0	0	14	0	0	0	0	0
Helisoma scalare	0	0	0	3	2	0	1	0	0	0	0	0	0	0	0	0	0	1
Physa sp.	0	0	0	0	1	0	1	0	0	0	0	0	9	6	2	2	1	1
CRUSTACEA																		
AMPHIPODA																		
Crangonyx-Synurella	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
Hayalella azteca	2	0	0	1	0	0	2	0	1	0	21	0	13	0	2	0	28	11
CLADOCERA																		
Unidentified sp.	0	0	0	0	0	0	0	0	0	0	1	1	0	0	4	0	5	32
COPEPODA																		
Unidentified sp.	0	0	0	0	0	0	0	0	0	0	48	39	3	0	2	7	10	55
DECAPODA																		
Procambarus sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISOPODA																		
Asellus sp.	3	0	0	15	0	0	0	0	0	0	58	2	15	0	4	0	31	0
OSTRACODA																		
Unidentified sp. A	0	1	0	0	0	0	2	0	0	0	0	0	3	0	7	0	2	0
Unidentified sp. B	0	0	0	16	0	14	0	0	0	0	0	33	0	19	2	49	0	14
INSECTA																		
ACARI (Water Mites)																		
Unidentified sp. A	21	5	20	13	8	1	22	28	6	36	0	1	2	0	0	3	0	1
Unidentified sp. B	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0
Unidentified sp. C	0	2	0	6	0	0	0	1	0	0	0	0	0	0	0	0	0	0
COLLEMBOLA (Springtails)																		
Hypogasturidae sp.	4	0	13	0	1	0	4	0	0	14	1	1	2	0	1	1	0	1

Table 2 . Continued.

SPECIES	Sta. 1A		Sta. 1B		Sta. 1C		Sta. 2A		Sta. 2B		Sta. 2C		Sta. 3A		Sta. 3B		Sta. 3C	
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
LEPIDOPTERA (Moths)																		
Unidentified sp.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
COLEOPTERA (Beetles)																		
Colpius sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Dineutus sp.	0	0	2	1	0	0	0	5	1	1	0	0	9	6	5	4	7	0
Dryops sp.	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Dubiraphia sp.	6	2	0	178	55	84	2	1	1	4	2	0	0	0	0	0	0	0
Dytiscidae (c.f. *Oreodytes*)	0	0	0	0	1	0	3	0	2	0	0	0	1	0	1	0	3	0
Helodidae sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Peltodytes sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Stenelmis (humerosa-sinuata gp.*)*	7	85	1	56	36	97	31	48	2	32	0	0	8	70	0	0	0	0
Unidentified sp.	0	0	0	0	1	0	1	0	2	0	1	0	0	0	0	0	0	0
DIPTERA (Flies)																		
CERATOPOGONIDAE																		
Unidentified sp.	39	14	9	11	32	12	1	10	15	4	0	1	11	24	3	55	15	6
CHAOBORIDAE																		
Chaoborus sp.	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	6
CHIRONOMIDAE (Midges)																		
TANYPODINAE																		
Ablabesmyia ornata	0	0	3	40	0	10	13	1	4	1	40	0	38	11	117	14	27	2
Clinotanypus sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Labrundinia floridana	2	0	2	0	1	4	0	0	3	0	0	1	18	7	13	2	19	5
Labrundinia virescens	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	5	0	6
Larsia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Unid. sp. (nr. *Larsia*)	0	0	0	0	0	0	0	0	0	0	0	1	0	22	0	26	0	2
Monopelopia boliekae	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	5

Table 2 . Continued.

SPECIES	Sta. 1A		Sta. 1B		Sta. 1C		Sta. 2A		Sta. 2B		Sta. 2C		Sta. 3A		Sta. 3B		Sta. 3C	
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
EPHEMEROPTERA (Mayflies)																		
Baetis spiethi	26	8	20	0	125	20	117	216	107	131	0	4	126	0	38	0	19	0
Caenis diminuta	0	2	0	15	3	35	0	0	0	0	7	0	6	0	17	0	15	20
Choroterpes hubbelli	0	0	0	0	0	0	0	1	0	5	0	3	0	21	0	15	0	21
Ephemerella trilineata	0	0	0	0	0	0	0	0	0	2	0	5	0	1	0	1	0	0
Pseudocloeon alachua	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0
Stenonema sp.	262	155	156	239	329	142	61	22	30	45	6	3	27	0	11	0	45	0
ODONATA (Dragonflies and Damselflies)																		
Argia sp.	0	0	0	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Chromagrion sp.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Dromogomphus sp.	3	0	0	21	5	16	1	0	1	1	0	0	0	0	0	1	0	0
Libellula sp.	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Macromia sp.	0	0	1	11	1	1	0	0	0	0	0	3	0	0	0	0	2	0
Nehalennia sp.	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Stomatochlora sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Sympetrum sp.	0	0	0	0	0	0	0	0	0	0	0	10	0	5	0	0	0	2
Triacanthagyna sp.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HEMIPTERA (True bugs)																		
Rheumatobates sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MEGALOPTERA (Dobsonflies Fishflies & Alderflies)																		
Corydalus sp.	0	4	0	2	0	5	0	2	0	1	0	0	0	0	0	0	0	0
TRICHOPTERA (Caddisflies)																		
Cheumatopsyche sp.	216	28	8	8	266	11	379	328	7	5	0	0	30	1	1	0	1	0
Chimarra sp.	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
Hydropsyche sp.	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Neureclipsis sp.	2	0	7	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0
Nyctiophylax sp.	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oecetis sp.	3	1	0	13	7	6	2	1	0	0	0	0	4	0	2	1	1	0

Table 2 . Continued.

SPECIES	Sta. 1A		Sta. 1B		Sta. 1C		Sta. 2A		Sta. 2B		Sta. 2C		Sta. 3A		Sta. 3B		Sta. 3C	
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
Polypedilum illiniense	0	0	0	0	0	0	5	0	1	0	118	30	388	17	219	50	58	33
Polypedilum scalaenum	11	14	6	63	13	117	86	57	62	44	0	1	15	62	1	17	6	0
Polypedilum sp.	0	0	0	0	0	0	3	0	2	1	2	0	0	0	3	0	0	0
Stenochironomus sp.	0	1	0	7	0	1	9	2	3	0	16	0	17	0	1	2	2	0
Tribelos fusicornis	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0
Unknown Chironomini sp.	3	0	113	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Tribe Tanytarsini																		
Cladotanytarsus sp.	2	0	0	2	18	31	10	4	0	0	0	0	8	0	0	0	1	0
Paratanytarsus sp.	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0	0	0	0
Rheotanytarsus exiguus	465	108	150	42	197	96	207	73	43	19	0	0	2447	5	54	0	82	1
Tanytarsus sp.	36	4	44	31	63	55	47	95	47	53	118	13	1235	200	1918	152	1433	30
Zavrielia sp.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
ORTHOCLADINAE																		
Corynoneura taris	16	0	75	0	32	1	16	4	55	1	8	0	82	0	20	0	51	0
Crictopus bicinctus	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Nanocladius (*Microcricotopus*) sp.	0	1	0	0	0	0	0	0	0	0	0	2	0	5	0	13	0	1
Psectrocladius vernalis	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Psectrocladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Rheocricoptopus robacki	61	6	174	7	46	0	89	13	71	5	0	0	7	0	5	0	2	0
Thienemanniella xena	484	0	281	0	109	6	478	31	530	10	0	0	11	2	0	0	2	0
Unknown Orthocladinae	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
EMPIDIDAE																		
Unidentified sp.	4	10	2	12	1	0	0	8	2	5	0	0	0	0	0	0	0	0
EPHYDRIDAE																		
Notiphila sp.	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
SIMULIDAE																		
Simulium sp.	99	45	15	6	24	21	153	155	2	1	0	0	1	0	0	0	0	0

Table 2 . Continued.

SPECIES	Sta. 1A		Sta. 1B		Sta. 1C		Sta. 2A		Sta. 2B		Sta. 2C		Sta. 3A		Sta. 3B		Sta. 3C	
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
Pentaneura sp.	0	0	0	0	0	17	0	5	0	8	0	0	0	10	0	0	0	0
Procladius sp.	0	3	3	16	2	4	4	0	1	0	0	0	15	2	39	1	11	0
Tanypus carinatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
Unid. Tanypodinae (*Macropelopia* gp.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	4
CHIRONOMINAE																		
Tribe Chironomini																		
Chironomus sp.	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4	4	0	8
Cryptochironomus blarina	0	0	0	0	1	13	1	1	0	2	0	0	0	0	0	0	10	0
Cryptochironomus (*fulvus* grp.)	3	1	0	0	4	11	0	5	0	1	0	0	0	0	0	0	0	0
Cryptochironomus (c.f. *rolli*)	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Cryptochironomus sp.	0	0	1	0	0	0	2	0	6	1	0	0	6	4	0	6	0	0
Cryptotendipes (pseudotener)	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Dicrotendipes modestus	0	0	0	0	0	0	1	0	0	0	29	92	0	40	23	73	8	29
Dicrotendipes nervosus	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	8	0	0
Glyptotendipes paripes	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Goeldichironomus holoprasinus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Kiefferulus dux	0	0	0	0	0	0	0	0	0	0	0	26	0	1	0	2	0	1
Lauterborniella sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Pagastiella sp.	0	0	0	10	20	0	0	0	4	0	0	0	0	0	0	0	0	0
Parachironomus carinatus	0	0	0	0	0	1	0	0	0	0	0	0	0	4	0	10	0	3
Paracladopelma sp.	2	1	0	0	0	0	8	0	2	0	0	0	9	0	0	0	0	0
Paralauterborniella nigrohalteralis	0	0	0	1	2	2	0	0	3	0	0	0	0	0	2	0	11	0
Paratendipes "connectens"	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Paratendipes subaequalis	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Polypedilum convictum	167	35	79	57	61	29	83	155	25	31	7	2	219	86	13	0	153	12
Polypedilum fallax	4	0	13	0	6	0	8	2	17	7	28	1	25	0	13	0	7	0
Polypedilum halteralis	64	27	53	57	26	11	1	1	49	1	0	1	0	0	3	0	4	0

Table 2 . Continued.

SPECIES	Sta. 1A		Sta. 1B		Sta. 1C		Sta. 2A		Sta. 2B		Sta. 2C		Sta. 3A		Sta. 3B		Sta. 3C	
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
TABANIDAE																		
Chrysops sp.	0	0	0	0	1	0	3	0	0	0	0	0	0	0	0	0	0	0
TIPULIDAE																		
Tipula sp.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified Diptera pupae	78	4	117	13	27	34	32	25	68	10	20	4	158	23	167	11	67	4
PISCES																		
Elassima evergladei	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Gambusia affinis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Ictalurus nebulosus	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	6	0	0
Total Number of Organisms/ Station	2202	634	1408	1196	2158	2239	2015	1620	1381	770	1065	506	5922	1152	3275	1293	3789	1636
Total Number of Species/ Station	38	31	31	45	50	51	48	36	38	41	27	37	44	35	38	36	41	39
Total Number of Species = 121																		
Total Number of Organisms = 34261																		

* Initially identified as *Sphaerium* sp., later found to consist of *Pisidium* sp. as well as *Sphaerium* sp.

Table 3 . Composite Species List for Ponar Grab Samples for the Winter (W) and Summer (S) Sampling Periods, 1978.

SPECIES	Sta. 1A		Sta. 1B		Sta. 1C		Sta. 2A		Sta. 2B		Sta. 2C		Sta. 3A		Sta. 3B		Sta. 3C	
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
COELENTERATA HYDROZOA																		
Hydra sp.	0	0	0	0	2	0	0	0	0	0	1	0	51	0	1	0	3	0
PLATYHELMINTHES TURBELLARIA																		
Unidentified sp.	2	0	0	7	1	3	1	0	0	0	9	1	1	0	0	0	5	0
RHYNCHOCOELA																		
Prostoma rubrum	0	0	0	2	13	8	1	0	0	0	0	0	0	0	0	0	0	0
ANNELIDA																		
Oligochaeta sp.	48	40	18	145	576	1206	49	181	178	167	43	61	178	236	206	387	1279	926
HIRUOINEA																		
Unidentified sp. A	3	0	0	2	0	1	0	0	5	0	170	2	6	4	0	6	0	1
Unidentified sp. B	0	0	0	0	0	0	0	0	0	0	11	0	4	0	0	0	1	0
Unidentified sp. C	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
MOLLUSCA BIVALVIA																		
Elliptio sp.	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0
Eupera cubensis	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Musculium sp.	3	5	3	13	1	9	20	2	1	7	0	0	0	8	0	14	0	0
*Pisidium-Sphaerium**	26	13	1	9	8	51	42	32	20	62	0	0	59	156	0	80	0	0
	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
GASTROPODA																		
Amnicola (s.g. Lyogyrus) retromargo	1	0	0	1	0	5	0	0	0	0	0	0	0	0	0	0	0	0
Ferrissia sp.	0	1	0	3	1	3	3	0	1	0	12	0	107	0	49	1	1	0

Table 3 . Continued.

SPECIES	Sta. 1A		Sta. 1B		Sta. 1C		Sta. 2A		Sta. 2B		Sta. 2C		Sta. 3A		Sta. 3B		Sta. 3C	
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
Gyraulus sp.	0	0	0	0	8	7	0	1	0	4	0	0	0	0	8	0	0	0
Helisoma duryi	0	0	0	0	0	0	1	0	0	0	0	0	14	0	0	0	0	0
Helisoma scalare	0	0	0	3	2	0	1	0	0	0	0	0	0	0	0	0	0	1
Physa sp.	0	0	0	0	1	0	1	0	0	0	0	0	2	0	1	0	0	0
CRUSTACEA																		
AMPHIPODA																		
Crangonyx-Synurella	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
Hayalella azteca	2	0	0	1	0	0	2	0	1	0	19	0	11	0	1	0	4	3
CLADOCERA																		
Unidentified sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4	0	3	26
COPEPODA																		
Unidentified sp.	0	0	0	0	0	0	0	0	0	0	36	26	2	0	2	5	2	52
DECAPODA																		
Procambarus sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISOPODA																		
Asellus sp.	3	0	0	14	0	0	0	0	0	0	39	0	14	0	4	0	18	0
OSTRACODA																		
Unidentified sp. A	0	1	0	0	0	0	2	0	0	0	0	0	3	0	7	0	2	0
Unidentified sp. B	0	0	0	16	0	13	0	0	0	0	0	18	0	0	0	5	0	6
INSECTA																		
ACARI (Water Mites)																		
Unidentified sp. A	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Unidentified sp. B	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0

Table 3 . Continued.

SPECIES	Sta. 1A		Sta. 1B		Sta. 1C		Sta. 2A		Sta. 2B		Sta. 2C		Sta. 3A		Sta. 3B		Sta. 3C	
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
COLLEMBOLA (Springtails)																		
Hypogasturidae sp.	4	0	13	0	1	0	4	0	0	0	1	1	2	0	1	1	0	0
EPHEMEROPTERA (Mayflies)																		
Baetis spiethi	1	0	0	0	6	6	8	0	2	0	0	2	4	0	0	0	4	0
Caenis diminuta	0	0	0	10	3	17	0	0	0	0	0	0	5	0	9	0	6	0
Stenonema sp.	2	0	0	6	2	0	3	1	1	1	1	0	2	0	0	0	2	0
ODONATA (Dragonflies and Damselflies)																		
Argia sp.	0	0	0	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Chromagrion sp.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Dromogomphus sp.	3	0	0	21	5	16	1	0	1	1	0	0	0	0	0	1	0	0
Libellula sp.	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Macromia sp.	0	0	1	11	1	1	0	0	0	0	0	3	0	0	0	0	2	0
Nehalennia sp.	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Stomatochlora sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
TRICHOPTERA (Caddisflies)																		
Cheumatopsyche sp.	0	1	0	0	7	11	0	0	0	0	0	0	2	0	1	0	1	0
Oecetis sp.	0	0	0	13	5	5	2	1	0	0	0	0	4	0	2	1	1	0
LEPIDOPTERA (Moths)																		
Unidentified sp.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
COLEOPTERA (Beetles)																		
Dineutus sp.	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Dryops sp.	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Dubiraphia sp.	6	2	0	178	55	84	2	1	1	4	2	0	0	0	0	0	0	0
Dytiscidae (c.f. *Oreodytes*)	0	0	0	0	1	0	3	0	1	0	0	0	1	0	0	0	0	0
Helodidae sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Peltodytes sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Stenelmis (humerosa-sinuata gp.)	4	0	0	4	19	20	27	0	0	0	0	0	8	0	0	0	0	0

Table 3 . Continued.

SPECIES	Sta. 1A		Sta. 1B		Sta. 1C		Sta. 2A		Sta. 2B		Sta. 2C		Sta. 3A		Sta. 3B		Sta. 3C	
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
DIPTERA (Flies)																		
CERATOPOGONIDAE																		
Unidentified sp.	39	14	9	11	32	12	1	9	15	2	0	1	11	20	3	51	12	6
CHAOBORIDAE																		
Chaoborus sp.	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	6
CHIRONOMIDAE (Midges)																		
TANYPODINAE																		
Albabesmyia ornata	0	0	0	40	0	6	13	0	1	0	2	0	2	0	6	0	0	0
Labrundinia floridana	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	5
Larsia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Monopelopia boliekae	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	5
Procladius sp.	0	3	0	16	0	4	0	0	0	0	0	0	0	0	19	0	4	0
Tanypus carinatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
CHIRONOMINAE																		
Tribe Chironomini																		
Chironomus sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4	0	0	4
Cryptochironomus blarina	0	0	0	0	1	13	1	1	0	2	0	0	0	0	0	0	10	0
Cryptochironomus (fulvus grp.*)*	3	1	0	0	4	11	0	5	0	1	0	0	0	0	0	0	0	0
Cryptochironomus (c.f. *rolli)*	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Cryptochironomus sp.	0	0	1	0	0	0	2	0	6	1	0	0	6	0	0	0	0	0
Dicrotendipes modestus	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Goeldichironomus holoprasinus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Kiefferulus dux	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	1	0	0
Lauterborniella sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Pagastiella sp.	0	0	0	10	20	0	0	0	4	0	0	0	0	0	0	0	0	0
Paracladopelma sp.	2	1	0	0	0	0	8	0	2	0	0	0	9	0	0	0	0	0
Paralauterborniella nigrohalteralis	0	0	0	1	2	2	0	0	3	0	0	0	0	0	2	0	11	0

Table 3 . Continued.

SPECIES	Sta. 1A		Sta. 1B		Sta. 1C		Sta. 2A		Sta. 2B		Sta. 2C		Sta. 3A		Sta. 3B		Sta. 3C	
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
Paratendipes "connectens"	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Paratendipes subaequalis	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Polypedilum convictum	2	1	0	37	11	11	6	0	0	0	7	2	0	0	13	0	4	3
Polypedilum fallax	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0
Polypedilum halteralis	64	26	53	56	26	8	1	1	49	1	0	1	0	0	3	0	4	0
Polypedilum illiniense	0	0	0	0	0	0	5	0	1	0	1	1	11	0	0	1	0	7
Polypedilum scalaenum	11	10	5	60	13	104	86	54	60	36	0	1	15	60	0	17	6	0
Polypedilum sp.	0	0	0	0	0	0	1	0	0	0	0	0	0	0	3	0	0	0
Stenochironomus sp.	0	0	0	7	0	0	9	2	3	0	16	0	17	0	1	2	2	0
Unknown Chironomini sp.	2	0	112	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Tribe Tanytarsini																		
Cladotanytarsus sp.	2	0	0	2	18	30	10	4	0	0	0	0	8	0	0	0	1	0
Paratanytarsus sp.	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Rheotanytarsus exiguus	0	1	0	0	107	80	16	0	0	1	0	0	12	0	0	0	0	1
Tanytarsus sp.	1	0	0	30	63	19	36	2	21	0	8	0	29	1	133	1	25	0
Zavrielia sp.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
ORTHOCLADINAE																		
Corynoneura taris	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0
Rheocricoptopus robacki	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Thienemanniella xena	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0
EMPIDIDAE																		
Unidentified sp.	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EPHYDRIDAE																		
Notiphila sp.	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
SIMULIDAE																		
Simulium sp.	0	0	0	0	1	21	0	0	0	0	0	0	0	0	0	0	0	0
TABANIDAE																		
Chrysops sp.	0	0	0	0	1	0	3	0	0	0	0	0	0	0	0	0	0	0

Table 3 . Continued.

SPECIES	Sta. 1A		Sta. 1B		Sta. 1C		Sta. 2A		Sta. 2B		Sta. 2C		Sta. 3A		Sta. 3B		Sta. 3C	
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
TIPULIDAE																		
Tipula sp.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified Diptera pupae	6	0	1	5	8	27	0	1	1	1	5	0	19	5	21	2	6	0
PISCES																		
Elassima evergladei	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Number of Organisms/Station	242	120	217	758	1034	1822	378	299	378	293	387	158	625	492	505	576	1422	1073
Total Number of Species/Station	26	15	11	36	43	37	39	17	23	17	21	22	36	10	26	17	29	21
Total Number of Species = 93																		
Total Number of Organisms = 10,779																		

*Initially identified as *Sphaerium* sp., later found to consist of *Pisidium* sp. as well as *Sphaerium* sp.

Table 4 . Composite Species List for Hester-Dendy Samples for the Winter (W) and Summer (S) Sampling Periods, 1978.

SPECIES	Sta. 1A		Sta. 1B		Sta. 1C		Sta. 2A		Sta. 2B		Sta. 2C		Sta. 3A		Sta. 3B		Sta. 3C	
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
COELENTERATA HYDROZOA																		
Hydra sp.	2	0	2	1	1	4	1	0	0	0	1	0	68	0	41	2	55	1
PLATYHELMINTHES TURBELLARIA																		
Unidentified sp.	1	0	1	4	1	0	1	0	0	0	2	10	1	0	0	0	36	7
RHYNCHOCOELA																		
Prostoma rubrum	0	0	0	4	0	1	0	1	0	2	0	0	0	0	0	0	0	0
ANNELIDA																		
Oligochaeta sp.	10	4	15	17	4	18	1	60	1	28	272	65	416	75	239	243	266	277
HIRUDINEA																		
Unidentified sp. A	0	0	0	0	0	0	0	0	0	0	7	44	0	0	0	0	0	0
MOLLUSCA BIVALVIA																		
Musculium sp.	0	0	0	0	0	0	0	0	0	0	0	0	2	4	0	0	0	0
*Pisidium-Sphaerium**	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0
GASTROPODA																		
Ferrissia sp.	0	0	0	0	0	0	0	39	0	5	3	15	41	1	6	1	1	83
Gyraulus sp.	0	0	0	0	0	0	0	1	0	3	0	0	5	3	6	13	1	1
Physa sp.	0	0	0	0	0	0	0	0	0	0	0	0	7	6	1	2	1	1
CRUSTACEA AMPHIPODA																		
Hayalella azteca	0	0	0	0	0	0	0	0	0	0	2	0	2	0	1	0	24	8

Table 4 . Continued.

SPECIES	Sta. 1A		Sta. 1B		Sta. 1C		Sta. 2A		Sta. 2B		Sta. 2C		Sta. 3A		Sta. 3B		Sta. 3C	
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
CLADOCERA																		
Unidentified sp.	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	6
COPEPODA																		
Unidentified sp.	0	0	0	0	0	0	0	0	0	0	12	13	1	0	0	2	8	3
ISOPODA																		
Asellus sp.	0	0	0	1	0	0	0	0	0	0	19	2	1	0	0	0	13	0
OSTRACODA																		
Unidentified sp. B	0	0	0	0	0	1	0	0	0	0	0	15	0	19	2	44	0	8
INSECTA																		
ACARI (Water Mites)																		
Unidentified sp. A	21	5	20	1	8	1	22	28	6	36	0	1	2	0	0	3	0	0
Unidentified sp. B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Unidentified sp. C	0	2	0	6	0	0	0	1	0	0	0	0	0	0	0	0	0	0
COLLEMBOLA (Springtails)																		
Hypogasturidae sp.	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	1
EPHEMEROPTERA (Mayflies)																		
Baetis spiethi	25	8	20	0	119	14	109	216	105	131	0	2	122	0	38	0	15	0
Caenis diminuta	0	2	0	5	0	18	0	0	0	0	7	0	1	0	8	0	9	20
Choroterpes hubbelli	0	0	0	0	0	0	0	1	0	5	0	3	0	21	0	15	0	21
Ephemerella trilineata	0	0	0	0	0	0	0	0	0	2	0	5	0	1	0	1	0	0
Pseudocloeon alachua	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0
Stenonema sp.	260	155	156	233	327	142	58	21	29	44	5	3	25	0	11	0	43	0
ODONATA (Dragonflies and Damselflies)																		
Sympetrum sp.	0	0	0	0	0	0	0	0	0	0	0	10	0	5	0	0	0	2
Triacanthagyna sp.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4 . Continued.

SPECIES	Sta. 1A		Sta. 1B		Sta. 1C		Sta. 2A		Sta. 2B		Sta. 2C		Sta. 3A		Sta. 3B		Sta. 3C	
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
HEMIPTERA (True Bugs)																		
Rheumatobates sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MEGALOPTERA (Dobsonflies Fishflies & Alderflies)																		
Corydalus sp.	0	4	0	2	0	5	0	2	0	1	0	0	0	0	0	0	0	0
TRICHOPTERA (Caddisflies)																		
Cheumatopsyche sp.	216	27	8	8	259	0	379	328	7	5	0	0	28	1	0	0	0	0
Chimarra sp.	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
Hydropsyche sp.	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Neureclipsis sp.	2	0	7	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0
Nyctiophylas sp.	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oecetis sp.	3	1	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0
COLEOPTERA (Beetles)																		
Colpius sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Dineutus sp.	0	0	2	1	0	0	0	5	1	1	0	0	8	6	5	4	7	0
Dytiscidae (c.f. *Oreodytes*)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	3	0
Stenelmis (humerosa-sinuata gp.*)*	3	85	1	52	17	77	4	48	2	32	0	0	0	70	0	0	0	0
Unidentified sp.	0	0	0	0	1	0	1	0	2	0	1	0	0	0	0	0	0	0
DIPTERA (Flies) CERATOPOGONIDAE																		
Unidentified sp.	0	0	0	0	0	0	0	1	0	2	0	0	0	4	0	4	3	0
CHIRONOMIDAE (Midges) TANYPODINAE																		
Ablabesmyia ornata	0	0	3	0	0	4	0	1	3	1	38	0	36	11	111	14	27	2
Clinotanypus sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0

Table 4 . Continued.

SPECIES	Sta. 1A		Sta. 1B		Sta. 1C		Sta. 2A		Sta. 2B		Sta. 2C		Sta. 3A		Sta. 3B		Sta. 3C	
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
Labrundinia floridana	2	0	2	0	1	4	0	0	3	0	0	1	15	7	12	2	19	0
Labrundinia virescens	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	5	0	6
Larsia sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Unid. sp. (nr. *Larsia*)	0	0	0	0	0	0	0	0	0	0	0	1	0	22	0	26	0	2
Pentaneura sp.	0	0	0	0	0	17	0	5	0	8	0	0	0	10	0	0	0	0
Procladius sp.	0	0	3	0	2	0	4	0	1	0	0	0	15	2	20	1	7	0
Unid. Tanypodinae (*Macropelopia* gp.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	4
CHIRONOMINAE																		
Tribe Chironomini																		
Chironomus sp.	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	4	0	4
Cryptochironomus (c.f. *rolli*)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Cryptochironomus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	6	0	0
Cryptotendipes (*pseudotener*)	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Dicrotendipes modestus	0	0	0	0	0	0	0	0	0	0	29	92	0	40	23	73	8	29
Dicrotendipes nervosus	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	8	0	0
Glyptotendipes paripes	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Kiefferulus dux	0	0	0	0	0	0	0	0	0	0	0	7	0	1	0	1	0	1
Parachironomus carinatus	0	0	0	0	0	1	0	0	0	0	0	0	0	4	0	10	0	3
Polypedilum convictum	165	34	79	20	50	18	77	155	25	31	0	0	219	86	0	0	149	9
Polypedilum fallax	4	0	13	0	6	0	8	1	17	7	28	1	24	0	13	0	7	0
Polypedilum halteralis	0	1	0	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Polypedilum illiniense	0	0	0	0	0	0	0	0	0	0	117	29	377	17	219	49	58	26
Polypedilum scalaenum	0	4	1	3	0	13	0	3	2	8	0	0	0	2	1	0	0	0
Polypedilum sp.	0	0	0	0	0	0	2	0	2	1	2	0	0	0	0	0	0	0
Stenochironomus sp.	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Tribelos fusicornis	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0
Unknown Chironomini sp.	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4 . Continued.

SPECIES	Sta. 1A		Sta. 1B		Sta. 1C		Sta. 2A		Sta. 2B		Sta. 2C		Sta. 3A		Sta. 3B		Sta. 3C	
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
Tribe Tanytarsini																		
Cladotanytarsus sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Paratanytarsus sp.	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Rheotanytarsus exiquus	465	107	150	42	90	16	191	73	43	18	0	0	2435	5	54	0	82	0
Tanytarsus sp.	35	4	44	1	0	36	11	93	26	53	110	13	1206	199	1786	151	1408	30
ORTHOCLADINAE																		
Corynoneura taris	16	0	75	0	32	1	15	4	55	1	7	0	82	0	20	0	50	0
Crictopus bicinctus	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Nanocladius (Microcricotopus) sp.	0	1	0	0	0	0	0	0	0	0	0	2	0	5	0	13	0	1
Psectrocladius vernalis	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Psectrocladius sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rheocricoptopus robacki	60	6	174	7	46	0	89	13	71	5	0	0	0	0	2	0	0	0
Thienemanniella xena	484	0	281	0	107	6	476	31	530	10	0	0	7	0	5	0	0	0
Unknown Orthocladinae	0	0	0	0	0	1	0	0	0	1	0	0	11	2	0	0	2	0
EMPIDIDAE													0	0	0	0	0	0
Unidentified sp.	4	10	2	5	1	0	0	8	2	5	0	0	0	0	0	0	0	0
SIMULIDAE																		
Simulium sp.	99	45	15	6	23	0	153	155	2	1	0	0	1	0	0	0	0	0
Unidentified Diptera pupae	72	4	116	8	19	7	32	24	67	9	15	4	139	18	146	9	61	4
PISCES																		
Gambusia affinis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Ictalurus nebulosus	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	6	0	0
Total Number of Organisms/Station	1960	514	1191	438	1124	417	1637	1321	1003	477	678	348	5297	660	2770	717	2367	563

Table 4 . Continued.

SPECIES	Sta. 1A		Sta. 1B		Sta. 1C		Sta. 2A		Sta. 2B		Sta. 2C		Sta. 3A		Sta. 3B		Sta. 3C	
	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
Total Number of Species/Station	23	23	25	24	22	30	21	29	24	32	20	25	29	34	25	29	30	29
Total Number of Species = 84																		
Total Number of Organisms = 23,482																		

*Initially identified as *Sphaerium* sp., later found to consist of *Pisidium* sp. as well as *Sphaerium* sp.

APPENDIX II

Benthic Taxonomic References

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